



Enhancing the Application of the Environmental Management System (EMS) in  
the UAE Aluminium Industry

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Submitted for the degree of Doctor of Philosophy

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August 2017

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## List of Abbreviations

EMS: Environmental Management System

EIA: Environmental Impact Assessment

EAD: Environment Agency- Abu Dhabi

NGO: Non-Governmental Organization

LCA: Life Cycle Assessment

EMAL: Emirates Aluminium Company

DUBAL: Dubai Aluminium Company

EGA: Emirates Global Aluminium

SPL: Spent Pot Lining

PFC: Per-Fluorinated Compounds

BAT: Best Available Technology

BATNEEC: Best Available Technology without Entailing Excessive Cost

ALARP: As Low As Reasonably Practical

SCM: Supply Chain Management

ISO: International Organization of Standards

AD EHSMS: Abu Dhabi Environment, Health and Safety Management System

GRI: Global Reporting Initiative

GEMI: Global Environmental Management Initiative

GHG: Greenhouse Gas

HF: Hydrogen Fluoride



## Abstract

Aluminium is widely used in all UAE construction related projects. However, the sustainability and the environmental performance of the aluminium production process is questionable. The production of this metal is associated with many environmental impacts, such as intensive energy consumption, emission of greenhouse gases, and generation of waste, which impacts the sustainable production of aluminium. One of the sustainable solutions is to create a sustainable metal whilst also making a positive net impact on the environment over the life cycle of aluminium products. Environment Management System (EMS) is proposed as an effective tool to control environmental impacts and improve the environmental performance of UAE upstream aluminium production industry. The question that this study tries to answer is how to effectively implement the EMS in order to control and manage the environmental and sustainability aspects of the UAE aluminium industry. This study reveals several gaps in the implementation of the EMS in the UAE aluminium industry such as inconsistent leadership commitment, weak communication, and poor environmental training quality. The aim of this study is to propose a framework for enhancing the implementation of the EMS in UAE aluminium industry. Firstly, the aim is achieved through conducting a questionnaire to identify external and internal factors affecting the implementation of EMS and diagnose its current status. Secondly, a case study is formulated to verify the findings obtained through the questionnaire by collecting on-site observations and conducting interviews of management and operational staff. Thirdly, a framework for effective implementation of EMS in UAE aluminium industry is proposed based on the elements found during the questionnaire and the case study stages. Finally, a robust qualitative and quantitative validation process of the proposed framework is conducted to achieve the final EMS framework output. The proposed EMS framework for UAE aluminium industry is envisaged to be mandatory for the industry and it includes human, organizational and systemic aspects. In addition, it tackles legal framework gaps identified in the UAE aluminium industry and prescribes an enhanced implementation process of the EMS in the UAE aluminium industry. This study contributes to the knowledge by adding a customized EMS framework for UAE aluminium industry. Further recommendations as a result of this study include cumulatively evaluating the EMS practices for all available aluminium production and

recycling stages, testing the framework when implemented in the aluminium industry and linking environmental planning and management outcomes for the aluminium industry. Moreover, it is proposed that a life cycle assessment inventory be created to feed into the Life Cycle Assessment (LCA) process gap identified in the UAE aluminium industry.

## ACADEMIC REGISTRY

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## Acknowledgement

I would like to thank my husband Ghanim Kashwani for his endless and continuous support during my PhD study and research process and for being a great father to our daughter Shamsa and a great husband. This work is dedicated to my angle Shamsa for when I see in her eyes is the hope of a better tomorrow. I would like to thank my mother Afrah Mohammad and my dear brothers, Essa, Mohammad, Ali and Habib for their kind support. You all made this work possible.

I would like to express my special appreciation and thanks to my supervisor Dr. Yasemin Neilson for her heartfelt support, sincere encouragement and continuous follow up during the PhD research process. Her guidance, motivation and spirit during the PhD have made the journey pleasant. In addition, I would like to thank Dr. Bilge Erdogan for her valuable comments and feedback received during various stages of the PhD work. Special thanks go to Dr. Assem El Hajj for laying the foundation of this work and for his generous assistance and guidance leading to the PhD major review stage. I would like to thank my framework external reviewers, David Monaghan and Waleed Nawaz, for their time, valuable comments and efforts made to review my proposed EMS framework. My thanks extend to the committee members, Dr. Frederic Bosche and Dr. Yusuf Arayici for their valued comments and suggestions that enhanced the quality of this PhD thesis.

*To my angel, Shamsa*

## **Chapter 1: Introduction - Background**

### **1.1 History and Development of Aluminium in Construction Industry**

The first effective usage of aluminium as a construction material in buildings started in 1930s. The first aluminium specification code was established in 1932 (Sharp 1994). The commercial production process of aluminium was developed in both U.S. and Europe around 1886, prior to which it was considered as a precious metal. Aluminium is the third most abundant element, after oxygen and silicon, and the most prevalent metal in the Earth's crust. Furthermore, it possesses unique characteristics such as light weight (density is one third compared to steel) and its ability to resist corrosion by forming a layer of aluminium oxide upon contact with air. Internationally, primary aluminium production has grown to more than 35 million tons per year since the 1940. The metal also offers a high strength/weight ratio, toughness and easy fabrication characteristics (Sharp 1994).

As such, there are many unique structural advantages of using aluminium alloys. In comparison to steel, both materials can provide efficient ductility that can resist mechanical challenges such as buckling, compression, tension and sheer yielding. This has lead engineers to employ aluminium in the design of complete structures such as beams and columns. For example, in 1933, the Smithfield Street Bridge in Pittsburgh, PA, was replaced by an aluminium deck due to the advantages of aluminium over steel (The Aluminium Association 2014). Aside from the mechanical properties of aluminium, according to Sharp (1993) the extrusion process is attractive for contractors and urban designers due to the relatively low extrusion cost when compared to other construction materials. Aluminium can also deliver a variety of different designed shapes. These distinctive features of aluminium, provides designers a freedom of selection and flexibility which grants them an effective metal placement on the construction site.

All these unique characteristics of aluminium play a vital role in influencing the construction materials landscape. As such, many countries have adopted the use and production of aluminium in the construction projects. For example, China reported producing 2,272 metric tonne of aluminium in 2014 according to World Aluminium (2014). This has critically changed the economic growth of China for the last seven years where in each year the economic growth increased rapidly at a rate of 10%. The massive change in the construction engineering field has

increased the demand for aluminium production raw materials. The increased production rate in turn provides third world countries with these raw materials, such as Bauxite, a chance to utilize their resources and boost their economic status (U.S. Bureau of Economic Analysis 1997).

Developing countries such as Gulf Countries, which mainly depend on oil and gas revenues as the main income for their economic strength, has realized the importance of the aluminium industry and its benefits in the construction and economic fields. Such an industry can serve as a vital alternative income source that helps in attaining a sustainable development and a balanced, diversified economy. There are, however, many environmental issues that can be considered real challenges and threats for the aluminium production to become a sustainable industry. United Arab Emirates (UAE) is considered one of the fast-growing nations among the developing countries in the Gulf region and its capital is Abu Dhabi. UAE has undergone a large-scale industrial development in the past 10 years. It has become a center for the growth of industrial projects in the region. Since the 1960s, the oil industry has been the main engine of UAE development, with Abu Dhabi being home to the sixth largest oil reserves in the world (about 98 billion barrels). Abu Dhabi also is the world's tenth largest oil producer, at around 2.5 million barrels per day (bpd) (Abu Dhabi Economic Vision, 2008). It is worth noting that UAE's economy is the second largest economy in the Arab world with a gross domestic product of \$ 377 billion recorded in 2012 after Saudi Arabia. The international monetary fund expects UAE's GDP to increase from \$403 billion in 2014 to \$448 billion in 2017 (International Monetary Fund 2012). It means that UAE's economy is constantly developing at a sharp rate and this growth is attributed to profits coming from many functioning sectors including the oil and gas sector.

It is vital; however, that Abu Dhabi creates a more sustainable pattern of growth, in which it can guarantee a healthy economic development without being subject to external factors such as oil prices and market fluctuation. The emirate is heading towards diversifying its economic income and not relying solely on oil and gas sector revenues. According to Abu Dhabi's economic vision, economic diversification is one of the key areas for the government. One of Abu Dhabi's immediate priorities of sustainable economic growth is to shift focus from oil based industries to non-oil based industries, guaranteeing a more sustainable economic growth and promoting foreign investment in large-scale domestic industrial projects. UAE currently is focusing on diversifying their economy where 71% of UAE's total GDP comes from



non-oil sectors, because economic diversification means economic sustainability (Abu Dhabi Economic Vision 2008).

## **1.2 Sustainability Issues of Aluminium in the Construction Industry**

“The aluminium industry is committed to advancing the sustainability efforts of its customers through the use of aluminium,” says Heidi Brock, president and CEO of the Aluminium Association (The Aluminium Association 2014). Through this statement, both the Aluminium industry and green building guidelines coincide to fulfill sustainable metal requirements for a green building. Redlbeck et al. (2004) agree with Sharp (1993) view and confirm that aluminium plays a major role in the sustainability of new buildings and the renovation of existing ones due to its performance properties. Aluminium contributes to the sustainable design, safety and comfort of new buildings. It has a unique feature due to its versatility, malleability and molding that can be used in upgrading existing buildings and historic structures. It lowers energy cost and carbon emissions in construction applications and even can be used in the production of renewable energy from solar sources as aluminium alloys are used in solar panels and cells. Properly coated aluminium roofs can reflect up to 95 percent of sunlight, helping improve building energy efficiency (The Aluminium Association 2015). At the end of its long lifespan, the high intrinsic value of aluminium acts as economic incentive for its recycling through a series of processes that make use of building scraps and cradle-to-cradle life cycle which achieve high environmental and economic benefits.

Other scholars, however, believe that there are many threats and challenges in the aluminium production process such as energy and environmental performances that can affect the sustainability of aluminium construction industry. Lawson (2006), for example, presents a comparison between several construction materials in the embodied energy levels at the operation and construction stages as shown in Fig. 1 and Fig. 2. Looking into the embodied energy levels of construction materials, it is clear that products with greater embodied energy have increased environmental impacts due to emissions and greenhouse gases arising from high energy consumption in the production process of these products. There is a difference between the embodied energy for construction materials and the embodied energy of materials when they are operational in buildings, as explained in Fig. 1 and Fig. 2. Aluminium has high embodied energy when it is extracted from Bauxite and processed as a metal through smelting as shown in

Fig. 1; while it has low embodied energy when used at the operational buildings due to its durability, as explained in Fig. 2.

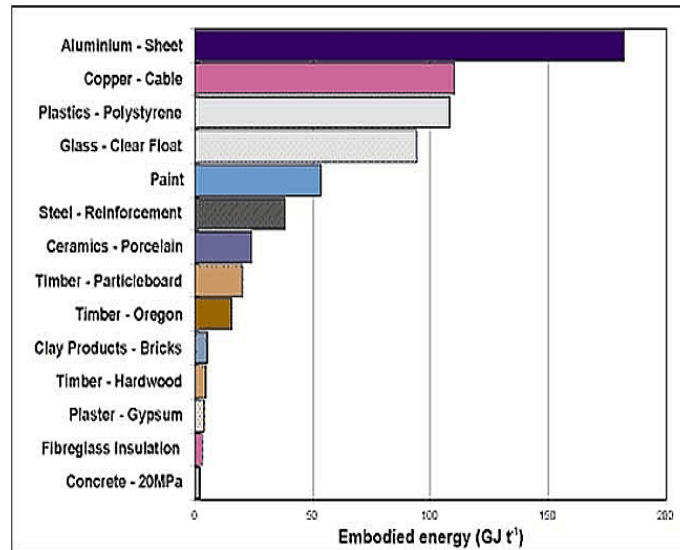


Figure 1: Embodied Energy of Construction Materials (Lawson 2006).

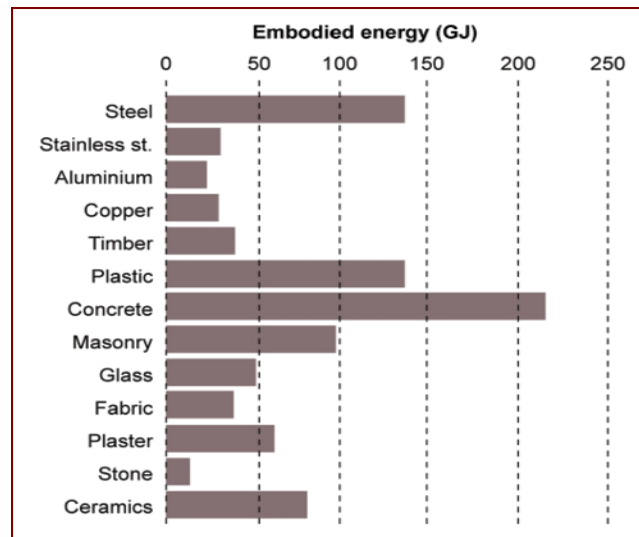


Figure 2: Levels of embodied energy for materials in Buildings (Lawson 2006).

According to Green (2007), most of the proposed solutions and practices towards enhancing and overcoming sustainability obstacles in aluminium construction consist of two components. The first one is from a recycling perspective where many construction scholars believe material recycling for aluminium will save major energy and environmental costs. Frees (2008), for instance, mentions that recycling one ton of aluminium as construction material can

reduce 2 tons of construction waste and 9 tons of greenhouse gases emissions. Conversely, many construction professionals suggest implementing best practices in the aluminium life cycle can improve the sustainability for the whole aluminium construction industry. Liu and Müller (2008), in their critical review, indicate that to solve and mitigate the high embodied energy consumption and deteriorated environmental performance, addressing sustainability best practices is the key. The authors believe that it can be achieved by various possibilities such as using new technologies that entails less energy consumption therefore leading to lower energy cost and production optimization in the operation process. In the end of the paper, both authors recommend employing EMS during the life cycle of aluminium to improve environmental releases associated with their upstream operations.

### **1.3 Aluminium Industry in the UAE**

UAE is a world leader in aluminium manufacturing and its related construction industry, putting it on the global grid when it comes to sustainable environmental performance (Dubai Aluminium Company Limited (DUBAL) 2014). According to the Gulf Aluminium Council (2009), there is a linear relationship between aluminium usage and the country's GDP. The wealthier the population, the more aluminium is being used in buildings, construction, transport, packaging and general engineering. There are still numerous environmental concerns in the aluminium industry such as energy consumption, resource management, emissions, air pollutants, and above all sustainability. According to Ewers and Malecki (2011), a closer inspect of the impacts of gulf mega-projects offers a great deal of understanding of the geographic and environmental implications of such projects. Given the vulnerability of the Gulf region to environmental stresses such as air pollutants, fragile marine and terrestrial ecosystem, water and electricity consumption, waste disposal etc., it is essential to further explore these environmental concerns in order to properly address the challenges and find suitable mitigation measures to address the associated environmental impact of the aluminium production.

There are many sectors that are expected to shape the economic diversification landscape of Abu Dhabi. Construction sector, construction related materials, construction supply chain and government services account for more than half of all employment. In addition, the metal industry is the third most important sector driving the economic growth after the energy (oil and gas) and petrochemicals industry. Abu Dhabi produces iron, steel, aluminium and other basic

metals. The metal sector is worth \$1,470 billion a year and it is estimated that the investment in metal and mining sector will increase at 19% a year in the future. The metal related profits are calculated at 27% increase a year which is quite significant (Abu Dhabi Economic Vision 2008). Ewers & Malecki (2011) said that developing economies likely to push on having key large-scale physical infrastructure projects in order to support employment, labor and capital costs, supply and demand in addition to offering economic diversification. This is exactly the case with the aluminium manufacturing and its related construction downstream sector in UAE. UAE is currently a home to two large-scale established aluminium smelters and an on-going alumina refinery project in the planning and feasibility stage that will soon be in the construction phase with operations expected to begin in late 2017.

#### **1.4 Environmental Management System (EMS)**

The role of the Environmental Management System (EMS) in properly addressing the environmental concerns of the industry is becoming more vital every day. For the aluminium production, these concerns include air emissions such as greenhouse gases, carbon dioxide, particulate matter, and nitrogen and sulfur combustion related emissions, process waste generation, and high energy demand required to produce aluminium. EMS is a tool that can be used to control these environmental concerns. There is no concise and agreed definition of environmental management because of its broad scope as well as its multi-disciplinary and interdisciplinary nature (Barrow 1999). According to the United States Environmental protection Agency US EPA (2014), environmental management is a set of processes and practices that allow the facility to reduce its environmental impact and increase its processes efficiency. It is an attempt to control human activities on the environment in a way that protects and maintains natural resources. In the context of an EMS, the US EPA defines EMS as a framework that helps companies in achieving their environmental objectives by controlling their operations. The ISO 14001 EMS standard defines EMS to be “the part of the overall management system that includes organizational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the environmental policy” (ISO 14001 EMS Manual 2004). It is more of an administrative function that develops, applies and monitors the environmental commitments and policies of the

organization. In simple terms, it is a set of practices that aim to control human activities and reduce pollution in order to preserve natural resources and, hence, the environment.

Environmental Management System (EMS) became important because of the many critical environmental concerns that require immediate attention such as global warming, widespread pollution, de-forestation, loss of bio-diversity and impact on human health (Colby 1991). Colby (1991) highlights that the scale and latitude of environmental issues are now greater than three decades ago. Many issues such as water scarcity, ozone depletion and increase of greenhouse gas emissions are pushing environmental concerns at the top of agendas in government agencies, companies and enterprises. Barrow (1999) agrees with Colby's view point and states that environmental management aims to manage the fast urban development in a way to guarantee human health and mitigate environmental impact. It focuses on the implementation, monitoring and auditing while coping with issues related to altering human impacts and damage to the environment. It should also work closely with environmental planning and must identify goals, determine if they are achievable, and then achieve them.

There are many international frameworks for the Environmental Management System (EMS) such as the ISO 14001 EMS and the EU Eco-Management and Audit Scheme (EMAS) all of which have their own set of standards and procedures. All of these standards share a similar aim which is putting a solid and workable framework for environmental management. Moreover, for EMS, there are environmental management tools that aid in achieving proper environmental management of the industry itself. In general, the environmental management tools may assist in simplifying the understanding of environmental impact caused by industrial systems (Ayarkwa et al. 2010). Several well-recognized environmental management tools and systems have demonstrated great results when it comes to industry environmental management. For example, in the planning and siting phase of any project, it is important to conduct an Environmental Impact Assessment (EIA) study. The EIA is an environmental planning and management tool that informs decision makers about the environmental aspects, impacts and possible mitigation measures of the proposed activity and nature of the project (Toro et al. 2013). It is even a regulatory requirement that an EIA is conducted for major projects. The EIA study evaluates the proposed location in relation to the activity and the possible impacts on vital ecosystem components such as air, soil, nearby water resources and groundwater. The sooner environmental concerns of the project can be identified the better suitable mitigation measures can be integrated

into the conceptual design phase. This makes the project more cost effective and environmentally acceptable (Macintosh & Waugh 2014). Jay (2006) mentions that EIA reports are prepared to ensure that environmental considerations are part of the planning and design processes. Addressing environmental concerns at this stage is much easier and less expensive rather than after operations have started. Furthermore, assessment reports help in defining baseline conditions, identifying potential impacts, preparing strategies to reduce impacts and increase communications.

According to the Department for Environment, Food and Rural Affairs' Environmental KPI's report, it is important to oversee environmental performance due to many financial and environmental benefits such as cost savings, productivity gains, improved sales and investment attraction (Defra 2006). The report mentions that the UK Environment Agency estimates British manufacturing would save £2–3 billion per year by adopting best practice waste minimization technique. Furthermore, 74% of the British population holds that access to information on the company's social, environmental and ethical behavior would influence their purchasing decision (Lewis 2003). This is relevant to the aluminium industry as an organization. Reducing the organization's impact on the environment and managing environmental issues of the organization can reduce exposure to fines and can improve relations with the regulators.

This has brought the question of the ability of the Environmental Management System (EMS) in effectively controlling the impact of aluminium production. With all of the benefits that the aluminium as a material can offer the construction sector, there is clear argument whether this metal can be called "Green" or "Sustainable" by looking into the adverse environmental impacts associated with its process of production. Aluminium manufacturing is an energy intensive industry and a major contributor to Greenhouse gases such as CO<sub>2</sub> and CFC, and PFC. Other air pollutants from this industry include HF and the typical combustion related gases such as NO<sub>x</sub>, SO<sub>x</sub>, PM (10 and 2.5) ... etc. Therefore, aluminium industrial complexes are usually coupled with power and desalination plants which utilize the waste heat and fulfill the concepts of industrial ecology and symbiosis. They are also set up in countries where the price of energy and fuel is considerably low, keeping in mind that in the UAE the price of energy and fuel is heavily subsidized by the government. This industry generates huge amounts of waste such as the Bauxite Residue from the Alumina Refinery process and the Spent Pot-Lining (SPL) from the Smelting process. It is worth noting that the science and technology for achieving

sustainability in aluminium industry is available; however, what is missing is the management of the system that runs these aspects which is the focus of this study. The environmental management of this vital industry is evaluated and enhanced through this study in order to aspire to the sustainability vision of the Emirate.

## 1.5 Rationale

When comparing aluminium with traditional construction materials such as iron and steel, aluminium may have higher embodied energy as shown in Fig.1. Its embodied energy is higher than steel due to the high-energy consumption going into making primary aluminium in the production stage. However, the embodied energy for aluminium installed in buildings is less than steel because it contributes to lower operating energy, as explained in Fig. 2. There is also less maintenance cost mainly because aluminium is a corrosion resistant metal. However, many construction experts believe that to reduce the embodied energy of aluminium as construction material, there is a need to evaluate the upstream production process of aluminium rather than looking into the downstream uses stage. Efthymiou et. al. (2010) describes aluminium as a “Green Metal” for being non-toxic, recyclable, light-weight and easily shaped, modern and durable. This has set the basis of sustainability formation for the aluminium as a metal used in construction field. However, it is still debatable whether aluminium is a green metal in spite of the high initial cost and the great amount of energy consumption during production. As mentioned previously, scholars proposed mainly two methods to resolve energy and environmental performance obstacles either by recycling the aluminium construction waste or enhancing the manufacturing process through different tools such as sustainable energy sources technologies and Environmental Management System (EMS). The second option could be more suitable for UAE since UAE aluminium industry is on upstream production and not on the downstream industries and uses such as recycling secondary aluminium.

UAE being home to aluminium manufacturing and its construction related industry marks UAE’s status as a major player in the global aluminium industry. Following China, Russia and Canada, UAE is the fourth largest aluminium producer, accounting for over 50% of the Arabian Gulf’s aluminium production (World Aluminium 2014). The aluminium production capacity was 2.4 million tonnes a year in 2014. About 300,000 tonnes are presently utilized in the country. According to a study by EC Harris (2013), UAE is projected to spend \$329 billion on major

construction projects by 2030. Thus, growth and investment in aluminium industry will continue. Since the aluminium manufacturing and its construction related industry has global implications in UAE, the question for this research work is to investigate whether the EMS in such industry is up to the global environmental standard.

Environmental Management System (EMS) tool aims at ensuring that the company complies with the environmental rules, guidelines, procedures and requirements of the regulatory and social context in which the company operates in (Colby 1991). There are many industrial plants in UAE claiming to have an EMS tool integrated within their operations. However, there is lack of research done about this topic in this part of the world. UAE is developing at a rapid pace, which places a huge burden on the environment and the natural resources to accommodate these changes. There is also lack of studies that investigate the environmental planning and impact mitigation at all stages of the project life time, including design, construction, operations and decommissioning. According to DUBAL sustainability report (2009), the UAE aluminium manufacturing and its related construction industry holds a good EMS status. Reaching aspiring levels of compliance, a leading aluminium manufacturer in the UAE mentioned that aluminium industry in the UAE is committed to attain the global environmental objectives set out in the Global Aluminium Sustainable Development Initiative (SDI) founded by the International Aluminium Institute (IAI). SDI is a worldwide voluntary industry approach to mitigation. This initiative provides sustainable measures for different industrial sectors. Attaining global sustainability standards allows the stakeholders to be more aware of the environmental performance of the company thus enabling them to make informed decisions about issues related to the business of the company (DUBAL sustainability report 2013). In order to understand the EMS status in the UAE aluminium industry, there is a need to compare it with the international operational status in other global aluminium industries. This industrial benchmarking exercise allows for a better understanding of the environmental performance in the UAE compared to global standards.

### **1.5.1 Environmental Performance Comparison**

The main obstacle to achieving higher environmental performance standards is the implementation of the Environmental Management System (EMS) and the related processes used in the aluminium production industry. The gaps are translated in the environmental management



of air emissions, solid and liquid waste, and water and electricity consumption. According to the Global Environmental Management Initiative (GEMI 1998), common environmental performance indicators include quantities of chemicals emitted to air, discharged to water or disposed as hazardous waste, and energy usage. The process of producing primary aluminium consumes large amount of energy and generates air emissions, solid and liquid waste.

An example of environmental performance comparison between the UAE aluminium industry and UC RUSAL is highlighted in Table 1. With regards to emission data in the UAE based aluminium industry from the period of 2007 to 2009, the volume of Sulfur Dioxide (SO<sub>2</sub>) emissions increased 5% due to a 7.4% increase in production level. In contrast, Nitrogen Oxides (NO<sub>x</sub>) emissions decreased 27% due to introduction of low NO<sub>x</sub> burner and utilization of best available technologies or best available technologies not exceeding excessive cost (BAT and BATNEEC). As for the Chlorofluorocarbon (CFC), emissions were 0.11 mt in 2008 and 0.12 mt in 2009. In addition, Hydrogen Fluoride (HF) emissions increased from 0.55 kg/mt Al to 0.64 kg/mt Al in duration of four months. Greenhouse gas (GHG) emissions in 2008 and 2009 were totaled to 7 million metric tonnes and 8 million metric tonnes of CO<sub>2</sub> in 2008 and 2009. Even after 2009, it seems that the increased production rate brings along increased pollution rate unless there is a good mitigation measure or a technology to reduce this pollution (DUBAL, 2013). Moreover, the increased pollution rate is partially attributed to the power outage incidents in 2008 that caused a significant impact on operations, increase in waste generation, Per-fluorinated compounds (PFC) and particulate dust emissions.

In comparison, UC RUSAL which is aluminium producing company located in Russia has reported in their sustainability report for 2009-2010 that investment in the development of environmental friendly technologies has reached USD 1 billion in order to reduce harmful emissions. For example, the total reduction in greenhouse-gas emissions at UC RUSAL was 130.8 thousand tonnes of CO<sub>2</sub> equivalent for 2008 and 749.3 thousand tonnes of CO<sub>2</sub> equivalent for 2008-2010. This was done while maintaining increased aluminium production level and increased sales. This finding confirms that UC RUSAL was able to manage their environmental aspects and impacts in a responsible and productive manner while in the UAE there were technological limitations that hindered reaching similar aspirations.

**Table 1. Environmental Aspects Comparison between UAE Aluminium Industry and UC RUSAL**

Aspects Comparison	UAE Aluminium Industry	UC RUSAL
Emissions	<ul style="list-style-type: none"> <li>• Increased SO<sub>2</sub> Emissions 5%</li> <li>• Decreased NO<sub>x</sub> Emissions 27%</li> <li>• Minor increase in CFC Emissions (0.11 mt in 2008 and 0.12 mt in 2009)</li> <li>• Minor increase in HF Emissions (0.55 kg/mt Al to 0.64 kg/mt)</li> <li>• Increase in GHG Emissions (7 million metric tonnes in 2008 and 8 million metric tonnes in 2009)</li> </ul>	<ul style="list-style-type: none"> <li>• Reduction in GHG Emissions (reduction of 130.8 thousand tonnes of CO<sub>2</sub> equivalent for 2008 and 749.3 thousand tonnes of CO<sub>2</sub> equivalent for 2008-2010)</li> </ul>
Electricity Consumption	<ul style="list-style-type: none"> <li>• Electricity consumption increased from 155.3 million (GJ) in 2008 to 172.9 million (GJ) in 2009</li> </ul>	<ul style="list-style-type: none"> <li>• 80% of all primary aluminium production is conducted using hydroelectricity</li> </ul>
Energy Sources	<ul style="list-style-type: none"> <li>• Natural Gas</li> </ul>	<ul style="list-style-type: none"> <li>• Hydro-electricity</li> </ul>
Waste	<ul style="list-style-type: none"> <li>• Volume of waste in 2008 was 13 % higher than in 2007</li> </ul>	<ul style="list-style-type: none"> <li>• Discharge of waste decreased more than 70%</li> </ul>

Another sustainability report was published for the period of 2010-2012 and is considered the most recent UAE aluminium industry sustainability report (DUBAL 2013). The volume of hydrogen fluorides (HF) emissions was 53% lower than of what was reported 2000. However, perfluorocarbons (PFC) emissions were not meeting targets set out by IAI. The used benchmark year for the PFC emissions comparison is 1990 which is unrealistic to measure against while it is reporting 88% less emissions than 1990. With the recent advancements in technology and environmental mitigation measures, a more robust PFC emissions management is expected. The

volume of sulfur dioxide emissions in 2012 was 15.1 kg/t higher than the 14.7 kg/t recorded in 2011, but 13.4% lower than 2009. This has been attributed to the decrease of sulfur in petroleum coke purchased, which is used in making the anodes for the electrolytic reduction process. The volume of nitrogen dioxide declined 30.5% since 2007 due to the low NO<sub>x</sub> burners, operational planning and machinery availability. The CFC emissions continued to decrease from 0.04 tonnes in 2010 to 0.02 tonnes in 2012 (DUBAL sustainability report 2013).

To understand the environmental impacts of the aluminium production, it is suggested to evaluate other industrial sectors operating in Abu Dhabi and have a closer look at their environmental impact. For example, the Iron and steel production is a material and energy intensive industry as well. More than half of the mass input becomes output in the form of off-gases, wastes, or by-products (European Commission 2001). The emissions from iron and steel facilities include particulate matter (PM), carbon dioxide (CO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>), and sulphur dioxide (SO<sub>2</sub>). For example, emissions for these pollutants were estimated to total 2,140 metric tonnes per year (MT/yr) for PM, 2,027,968 MT/yr for CO<sub>2</sub>, 6,342 MT/yr for NO<sub>x</sub>, and 451 MT/yr for SO<sub>2</sub> for all four iron and steel facilities in Abu Dhabi. Other environmental releases include wastewater that is reused and recycled within the process of iron and steel making.

The main solid waste from iron and steel facilities is furnace slag that is not directly recycled in the facilities but can be sold for reuse in other industries (Environment Agency – Abu Dhabi 2010). This is a very common environmental challenge that occurs currently in many advanced industrial countries (World Steel Association 2015). Since the iron and steel industry is energy intensive, it is a major contributor to greenhouse gas (GHG) emissions. According to the Intergovernmental Panel on Climate Change, the steel industry accounts for between 3% and 4% of total world GHG emissions. On average, 1.8 tonnes of carbon dioxide (CO<sub>2</sub>) are emitted for every tonne of steel produced (World Steel Association 2015), keeping in mind that most of the steel produced in UAE originally is recycled so there is huge cut back from emissions by using secondary processes. In comparison, 1.5 tonnes of carbon dioxide (CO<sub>2</sub>) are emitted for every tonne of aluminium produced that is by utilizing best available technologies for clean production, whereas previously in 1990, CO<sub>2</sub> emissions level were of about 2.25 tonnes of CO<sub>2</sub> emitted by tonne of aluminium produced (World Aluminium 2014). However, by looking at the entire lifecycle of aluminium, Huglen and Kvande (1994), estimated the global mean emissions of

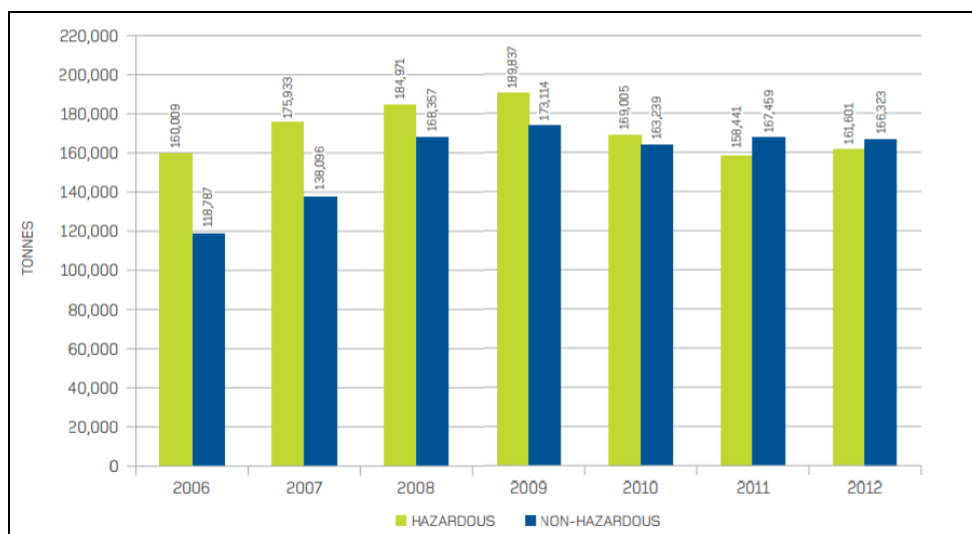
about 12 tonnes of CO<sub>2</sub> per ton of primary aluminium that include mining, processing of ore, electrolysis, electricity generation and casting of metal.

With regards to electricity and water consumption in the UAE aluminium production, the total energy consumption in 2008 was 155.3 million gigajoules (GJ), which has risen to 172.9 million (GJ) in 2009. In 2008 and 2009, 117,500 m<sup>3</sup> of water was withdrawn per hour and 96% of this water was used for cooling purposes only to be returned back to sea. The rest of the water is in the content of the brine discharge from the desalination process. Pertaining to the waste, the volume of waste in 2008 was 13 % higher than in 2007 (DUBAL sustainability report, 2009). In 2010, the total energy consumption per tonne aluminium produced was 170.79 million gigajoules (GJ) which has reduced marginally in 2012 to 164.04 (GJ). The main source of electricity generation is through natural gas. As for the average water abstracted from sea per hour, it is estimated as 134,142 m<sup>3</sup> of which was 84% cooling water returned to sea. The total quantity of waste generated from process operations has increased in 2011 and declined in 2012. It is also noted that the waste is reported differently in both 2009 and 2013 sustainability reports (DUBAL sustainability report 2013). In comparison, UC RUSAL estimates in their sustainability report that nearly 80% of all primary aluminium production is conducted using hydroelectricity, which entails the production of electricity through water power that creates a minimum of emissions. Again, this reflects that in the UAE, there may be geographical and environmental limitations to convert to specific types of renewable energy.

Sustainable renewable energy source is of utmost interest to the UAE. According to the International Renewable Energy Agency (IRENA), UAE renewables will be accounting for 25% of total power generation, increasing annual savings to USD 1.9 billion by 2030. By factoring health and environmental benefits in transitioning to renewable energy sources, the savings could reach to 3.7 billion by 2030 (IRENA 2015). In terms of operational fuel, aluminium smelting industry is running on natural gas based power. Solar and nuclear energy can be used as alternative fuel supplying the electricity grid. However, the aluminium smelting activity requires non-fluctuating continuous supply of electricity through conversion of Alternative Current (AC) to Direct Current (DC). Therefore, there are technological limitations in using solar energy mainly because it has not been tailored sufficiently to satisfy the continuous energy need of the aluminium smelting industry. On the other hand, the alumina refinery industry has been successfully using solar energy as an alternative sustainable fuel in Australia (Vorrath 2016).

Abu Dhabi is currently constructing their first alumina refinery (Shaheen Project) in which alternative solar fuel can be further explored given the abundance of solar energy in this region. Using other alternative sources of energy generation, waste to energy concept has been successfully implemented in Dubai aluminium company (DUBAL) where the waste heat is utilized for other purposes within the industrial complex such as water desalination. In addition, the UAE expects the launch of its first Nuclear Energy plant in Barakah in late 2017 which is believed to supply a quarter of the UAE's electricity needs (ENEC 2015). This would certainly be of interest to the aluminium smelting industry where such energy is considered clean and reliable.

In terms of waste management, statistics show that over 10 million tonnes of waste each year is produced in Abu Dhabi alone, with about 662,841 tonnes per year comprising of industrial waste only. The nature of industrial process waste coming out from the aluminium industry is hazardous and non- hazardous waste. According to DUBAL sustainability report (2009), spent pot lining and spent anodes are the largest proportion of waste by weight. The total amount of waste generated was 353,328 tonnes in 2008 and rose to 362,951 tonnes in 2009. The volume of waste increased 13% in 2008 than what is used to be in 2007 due to the implications from power outage incident and from increased production rate. In 2010-2012, there is a general decline in the amount of generated waste. Fig. 3 displays the generated quantity of hazardous and non-hazardous waste from 2006 to 2013 (DUBAL sustainability report 2013).



**Figure 3: Relative Proportion of Hazardous and Non-Hazardous Waste Production in UAE Aluminium Industry, 2006 to 2012 (Dubai Aluminium Company Limited 2013)**

In terms of environmental sustainability, it is imperative to find a better method to reduce the ever-increasing waste production rate without affecting production efficiency. Furthermore, the activation of the 5 R system (reduce, re-use, recycle, recover, and responsible disposal) should be in place to make sure that waste is being recycled, treated or land-filled. The latter technique should be the last resort so as to stay within the waste management strategy of Abu Dhabi in diverting about 85% of waste from landfills (Environment Agency Abu Dhabi (EAD) and Center of Waste Management (CWM) Annual Policy Brief 2013). In comparison, UC Rusal companies produced 13.7 million tonnes of waste in 2009 and about 14.4 million tonnes of waste in 2010. However, the amount of processed waste also increased; 1.6 million tonnes of waste was processed in 2009 and 3.4 million tonnes of waste was processed in 2010.

A copy of the UAE aluminium sustainability report for the year 2008-2009 was attained and a combined sustainability report was produced for 2010-2012. It is extremely a difficult process gathering sustainability related data in such industry and being a role model to industries around the UAE, Emirates Global Aluminium (EGA) was one of the few industries who started publishing sustainability reports. They were at times challenged for many reasons including budget and transparency with regards to environmental performance, disclosing information related to environmental performance due to their sensitivity and their effect on the business of the company. However, managing in a rapidly progressing economy have focused the purpose of investigating the Environmental Management System (EMS) efficiency of the aluminium industry into enhancing the environmental management in this vital industrial sector. This will advance the overall understanding of environmental sustainability issues and environmental management concerns for the aluminium production sector. It will also propose a better framework to implement sound environmental management practices.

The data mentioned above provides a clear idea about the environmental sustainability performance of the aluminium industry in UAE. There are gaps in the implementation of the Environmental Management System (EMS) and sustainability performance in this industry. In a way, the environmental performance of such vital industry is not reaching global standards. There are sufficient technological advancements in the industry; however, the implementation of a robust framework to manage environmental concerns is missing. There are many initiatives undertaken to limit the environmental impact and decrease the environmental footprint of the

aluminium industry but the extent and the efficiency of these mitigation measures and initiatives in reducing impacts are still not fully investigated.

Environmental Management System (EMS) attempts to decrease environmental concerns and accidents, health issues and severe impacts to the environment. By assessing the performance of the Environmental Management Systems (EMS), one can reduce environmental impacts and increase productivity (Qien 2001; Blanchard et al. 1998). The environmental management systems are tailored according to industry's process and the type of activities conducted in the plant. Some of the major components of the environmental management systems are risk assessment, hazard evaluations and sound environmental planning at the initiation of the project. Through environmental risk assessment, areas of major environmental concerns are well-managed and mitigated leading to a decrease in impact significance and the severity of accidents. Using environmental planning tools, industrial plants can be well managed and proper mitigation measures can be implemented at the early design stage, thus decreasing the cost significantly and improving the environment quality. Both environmental planning and risk assessment will complement each other in order to achieve an integrated framework to reduce impacts and accidents by providing a sound environmental management. Since continuous improvement is another major component of the EMS, it is suggested to have robust control system for continuous assessment and improvement of the EMS at the industrial plant. Monitoring of the performance is essential part of the equation and would usually include monitoring key performance indicators related to EMS such as air pollutants emissions, number of accidents or near-misses. Reporting also plays a significant role in the success of the EMS and this usually comes from a well promoted EMS culture in the work environment.

The investigation carried out in this study reveals that the main environmental concern of the aluminium production sector in UAE is the robust implementation of the Environmental Management System (EMS) and the strength of the environmental planning and environmental risk assessment. The main question that this study tried to answer which is how to effectively implement the EMS in order to control and manage the environmental and sustainability aspects of the UAE aluminium industry. As explained, global aluminium production industry could achieve high production levels with minimum environmental pollution. Factors affecting proper implementation of EMS in the UAE will be further explored. In addition, a proposed framework to enhance implementation of the EMS is suggested through this study.

## 1.6 Aim and Objectives

The aim of the study is to propose a framework to enhance the implementation of the Environmental Management System (EMS) in the UAE aluminium industry. To achieve this aim, the factors affecting the efficiency of EMS in the aluminium production industry must be identified. The EMS will be evaluated and examined as to how effective it is in reducing environmental impacts and controlling major environment related concerns within this industry. This in turn, will make produced aluminium a more sustainable metal for application in the construction industry. When sustainable practices are employed in producing aluminium, the associated metal production processes have reduced environmental impacts. Therefore, the application of the final product in the construction industry is following green building design parameters by minimizing the environmental impacts of aluminium production within the supply chain. The need to improve environmental management efficiency is related to many factors such as regulatory compliance, company reputation and improved production efficiency.

This research intends to further explore the Environmental Management System (EMS) in the aluminium production industry, specifically in the UAE. Several factors may be investigated that include human factors, organizational factors and system factors. Each of these factors has several contextual life dimensions that tackle culture, society, industry, education, knowledge, skills, cost, timeline and manpower.

The main objectives of this study are summarized in Table 2. Further description on the objectives of this study are as follows:

- **Objective 1:** Analyzing external and internal factors affecting the implementation of the EMS in the UAE aluminium production industry to have more sustainable metal in the construction industry.
- **Objective 2:** Critically evaluating the effectiveness of Environmental Management System (EMS) that is used at the aluminium production industry and reviewing EMS tools such as measurement and improvement, pollution prevention and resource conservation, environmental gap analysis, environmental benchmarking, and environmental best practices.



- **Objective 3:** Developing an integrated framework for the implementation of the EMS in the UAE aluminium production industry to ensure sustainability of metal usage in the construction industry.
- **Objective 4:** Validating the proposed EMS framework qualitatively and quantitatively to ensure its applicability, efficiency and usefulness for the UAE aluminium industry.

**Table 2. Study Aim, Objectives and Mapped Methodology**

<b>Study Aim</b>	Propose a framework to enhance the implementation of the Environmental Management System (EMS) in the UAE aluminium industry	
No.	<b>Objectives</b>	<b>Methodology</b>
1	Analyzing external and internal factors affecting the implementation of the EMS in the UAE aluminium production industry	Detailed industry-specific questionnaire is designed to evaluate EMS performance and identify its strengths and weaknesses
2	Critically evaluating the effectiveness of Environmental Management System (EMS) that is used at the aluminium production industry	Detailed industry-specific questionnaire results analysis Case study observations and interviews to verify the results obtained from the questionnaire
3	Developing an integrated framework for the implementation of the EMS in the UAE aluminium production industry	Analyzing outcomes of the questionnaire and the case study observations and interviews
4	Validating the proposed EMS framework qualitatively and quantitatively to ensure its applicability, efficiency and usefulness for the UAE aluminium industry.	Conducting interviews with industry professionals and external reviewers and incorporating their feedback in the proposed framework. Retrospectively analyze KPIs proposed for quantitative EMS framework validation

The first objective can be achieved through EMS performance evaluation and identifying strengths and weaknesses via a detailed industry-specific questionnaire as indicated in Table 2. This can be done through assessment of the following three factors affecting the Environmental Management System (EMS) in the UAE aluminium production industry:

- Human factors such as skilled and trained labor;
- Organizational factors such as management commitment and work environment; and
- System factors such as used standards and management systems

The assessment of these factors allows one to gain a clear understanding of the external and internal factors affecting the Environmental Management System (EMS) such as external complex governmental systems, internal leadership visibility and enforcement gap. This research will explore the factors affecting EMS from the point of view of aluminium production industry in particular through surveys and investigation as other environmental scholars tried (González 2004). In addition, this study can be viewed as additional and a continuation to the work presented by González in 2004 on the topic of motivation and barriers of implementing EMS in Spanish organizations.

The second objective will be achieved through the industry specific questionnaire in addition to a case study to verify the results obtained from the questionnaire as explained by Table 2. This will help identify how sustainable the usages of aluminium in the construction site. In addition, evaluation of five environmental management tools used at the aluminium production industry will be conducted and they are as follows:

1. Measurement and improvement
2. Pollution prevention and resource conservation
3. Environmental gap analysis
4. Environmental benchmarking
5. Environmental best practice

Through evaluating these environmental management tools and their application in the aluminium production industry, a conclusion can be drawn on the most effective tools that will ensure sound environmental management of the UAE aluminium plants. These environmental management tools are not solely used in the aluminium production industry and they can be applied across all major heavy industries. There are other environmental management tools that are not used directly in the operational phase; rather they are mainly applied in the planning stage

such as the Environmental Impact Assessment (EIA). Darnall (2008) investigated how businesses can be improved through the implementation of environmental management tools in order to enhance efficiency. This research will draw on the conclusions derived from the implementation of environmental management tools in the aluminium production industry to have more sustainable aluminium for the construction industry. A case study will be conducted to verify the results and conclusions obtained.

The third objective will be facilitated by assessing the previous gaps in the Environmental Management System (EMS) found by the questionnaire and the case study, as explained in Table 2, in order to generate an integrated framework to better implement EMS in the aluminium production industry. This includes analyzing the use of aluminium within the industry, and related sustainability rules, regulations and rating systems that addresses the Life Cycle Assessment (LCA) of aluminium, since the LCA process is an integral part of the EMS. The framework will be developed based on the outcomes of the questionnaire and the case study.

To develop the EMS proposed framework, the impact of sustainable aluminium production on construction sector can be further studied. The sustainability regulatory system in Abu Dhabi including the environmental management and assessment, regulatory bodies and their roles in sustainability and environmental compliance that impact the aluminium sustainability and life cycle processes will be discussed further. Different opinions and enhancement options will be presented as part of the discussion. This step is vital to understand the current status of sustainability rules and regulations in the UAE so that the proposed framework followed by the implementation guideline does not re-invent the wheel and propose a new methodology for a process that is already existent. The framework, rather, is envisioned to compliment the current sustainability systems and processes in the UAE in general and Abu Dhabi in particular.

After achieving the third objective, there will be a need to validate the proposed framework by the industrial experts and external reviewers, as illustrated in Table 2. This lead us to the fourth objective which is validating the proposed EMS framework qualitatively and quantitatively for its applicability, efficiency and usefulness to the UAE aluminium industry. The qualitative assessment is mainly achieved through conducting interviews with industry professionals and external reviewers while quantitative assessment can use previous data for EMS retrospective analysis. This examination aids the study to determine how the framework will be feasible to provide construction end users a more sustainable metal. Therefore,

quantitative and qualitative assessments enable measurement of applicability and adaptability of the framework. As result of that, modifications can be added to framework to provide a suitable mechanism for the conceptual and functional aspects.

## **1.7 Contribution to Knowledge**

In global terms, the United Arab Emirates is a relatively young country with respect to environmental regulations, and implementation of effective environmental management practices. The country is undergoing a significant maturation phase, which in turn places huge pressure on sustainability and environmental resources. It is important to balance economic development with sound environmental practices to preserve available resources and create a sustainable way of living. As explained, the aluminium industry in the UAE is reaching aspiring global economic, productive and commercial standards; however, the question remains whether the environmental management system in this industry is up to the global environmental standards. There is a lack of comprehensive studies examining environmental management systems that affect the production of a major metal for the construction industry in UAE. Furthermore, there is a lack of studies exploring the regulations and rating system of sustainable aluminium use in construction. It is also important to understand the factors that affect the Environmental Management System (EMS) within the UAE aluminium industry. A holistic view of the entire life cycle of aluminium production is required to understand the environmental impacts of this vital industry. Many studies have looked at selected aspects of EMS and associated tools, such as Darnall (2008), Potoski and Prakash's (2013) EMS related works. Still, there is a lack of integrated studies which take into account environmental planning, impact mitigation and decision making at different stages of the project life time, whether it is conceptual design, construction, operation or decommissioning stage. There is currently no solid mandatory framework for implementation of EMS in UAE Aluminium Industry. This is certainly a new research area that can be further explored in due course.

## **1.8 Contribution to Practice**

It is clear now that in the aluminium industry, there are many environmental and sustainability concerns. The purpose of this research is to further investigate the efficiency of the Environmental Management System (EMS) in the UAE aluminium production and to determine

the factors affecting the proper implementation of the EMS in this industry. The advantages of improving the environmental management efficiency include:

- Positively affecting the quality of individual's lives including employees and the general public, in terms of environment, health and safety. Reduced air emissions mean less air pollution and better environmental accountability for the company's activities.
- Reducing volume of waste and enhancing utilization of resources will save cost on the company and will eliminate unnecessary processes. This means efficiency in water usage, waste reduction, purchasing and transport. Improved environmental management leads to improved production efficiency by implementing lean manufacturing concepts.
- Supporting secondary industries emerging from sustainable aluminium production and enhancing other recycling and pollution reduction sectors by generating jobs through the implementation of circular economy concepts (socio-economic benefit).

Improving environmental management efficiency will ensure compliance with basic regulatory requirements and will enhance company image. In addition, environmental management will address environmental risks and propose risk mitigation strategies. Adoption of sound environmental management practices will also demonstrate company's responsibility towards its stakeholders, whether regulatory authorities, public or company's clients.

## **1.9 Introduction Summary**

The question that this study tries to answer is how to effectively implement the EMS in order to control and manage the environmental and sustainability aspects of the UAE aluminium industry. This question is further answered through the aim of this study which is to propose a framework for enhancing the implementation of the EMS in UAE aluminium industry. Several sub-objectives are proposed in order to fulfill the overall study aim. The following literature review chapter will provide background information on the EMS and the aluminium industry globally and locally. The main environment and sustainability challenges of the industry will be discussed in the literature review section.

## Chapter 2: Literature Review - The Environmental Management System in the UAE Aluminium Industry

### 2.1 The Current Environmental Challenges of the Aluminium Industry

In order to understand the current environmental challenges of the aluminium industry, it is essential to review the global stand of the aluminium industry, how aluminium metal is manufactured and who are the major aluminium industries that are operating in the UAE. The history on the Environmental Management System (EMS) establishment and its application in different organizations is further reviewed in this literature review. In addition, barriers to the implementation of EMS in industries are investigated and used as a basis to form the methodology of this study. The literature review provides an overview of the aluminium life cycle and sheds some light on its sustainability challenges.

#### 2.1.1 The Global Perspective of the Aluminium Industry

Aluminium metal is a conductor that has many applications and uses. It is used in making automotive parts, kitchen foils, aluminium doors and window sides, vehicle bodies etc. The use of aluminium grew fast after commercial operations were established. Fig. 4 sheds light on how the rise of aluminium production grows exponentially after 1960s.



Figure 4: World Production Trend of Aluminium (The Aluminium Association 2014).

To understand the environmental implications of managing the aluminium production industry, one needs to have a closer look at how aluminium as a metal is produced and how industrial mega-aluminium structures are build. According to the World Aluminium report (2014), the world primary aluminium production is estimated as 4,477 thousand metric tonnes, and almost half of this production is centered in China with a reported production rate of around 2,084 metric tonnes as shown in Fig. 5 and Fig. 6. The GCC aluminium production rate comes second after China with around 426 thousand metric tonnes of aluminium produced by October 2014.

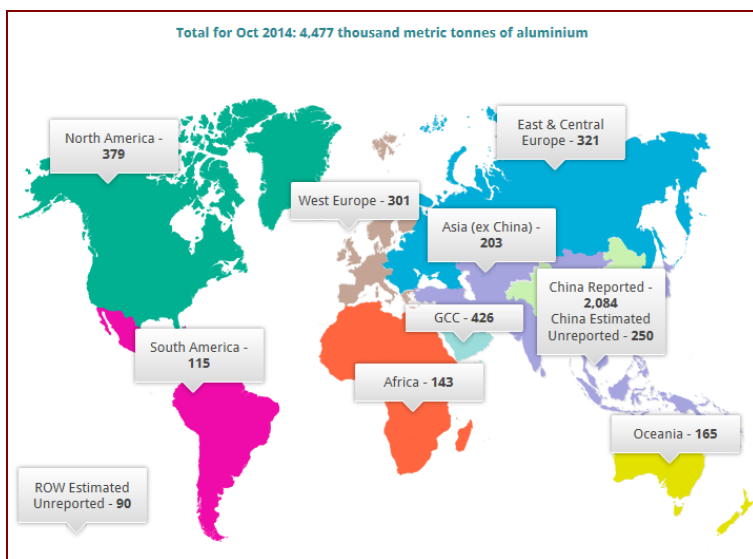


Figure 5: Primary Aluminium Production Globally (World Aluminium 2014).



Figure 6: Alumina Production by country (World Aluminium 2014).

According to the Global Aluminium Sustainable Development Initiative (2003), global primary aluminium production in 2001 was 24.5 million tonnes. Since 1888, 660 million metric tonnes of aluminium is produced. The largest global aluminium production is concentrated in Asia. Following this, North America, Russia and Europe take a large portion of the global aluminium production. A closer inspection reveals that Australia, Africa and South Africa are the major Bauxite resources countries, as can be seen in Fig. 7. Although Africa possesses high levels of Bauxite resources, there are no capabilities or facilities for aluminium production.

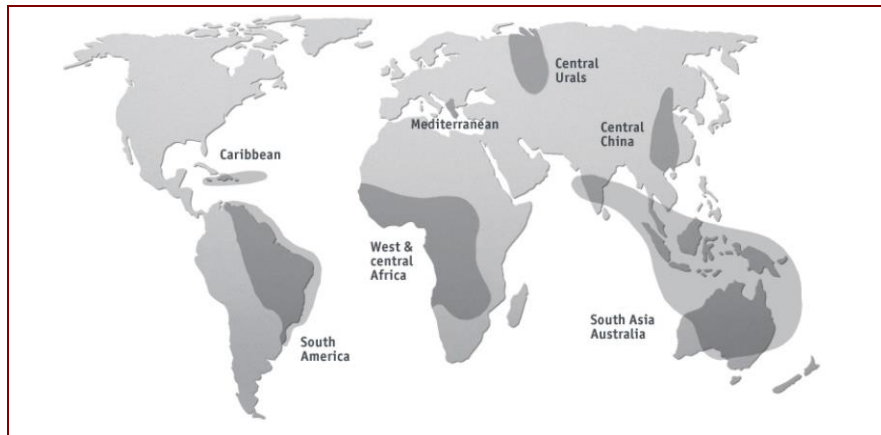


Figure 7: Major Bauxite Areas (World Aluminium 2014).

### 2.1.2 The Aluminium Manufacturing Process

The aluminium production from Bauxite mining to refining and smelting is a very energy intensive process and a source of many environmental and health related concerns (Russell 1997). The major problem that this particular industry, among other industries as well, is facing is the absence of an integrated model for environmental management. When it comes to the environmental management of the aluminium industrial complex, several functions are involved including engineering, design and build. All these functions ideally should keep in mind environmental considerations at the early design and planning phase in order to reduce environmental issues that already exist as part of the manufacturing process. Evaluating the regulatory context involved and the Environmental Management System (EMS) and assessment requirements used will enhance the understanding of the challenges faced in such industry.

According to Hatch (1984), aluminium is made from the raw material Bauxite, which is found mainly in the top soil of countries near the equator. The major Bauxite producers in the world include Australia, China, Brazil, India, and Guinea (Gendron 2013). The Bauxite is mined



and processed in an aluminium refinery through the Bayer process. The process requires building installations that supports extracting the alumina from bauxite ore through crushing, digestion using caustic soda, clarification where the bauxite residue is largely produced then precipitation and calcination. Fig. 8 is an illustrative diagram of how Alumina is extracted from Bauxite (Bauxite Resources 2014).

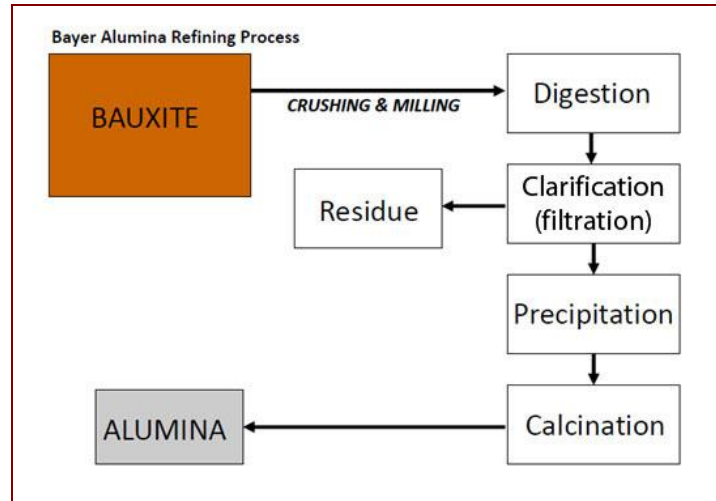


Figure 8: Alumina Refinery Process (The Aluminium Association 2000).

Around 7 tonnes of impure Bauxite produce 2 tonnes of Alumina through refining. Afterwards, the 2 tonnes of Alumina smelts into 1 tonne of aluminium (The Aluminium Association 2000). In other references such as Dubai Aluminium Company Limited Sustainability report, it is mentioned that it takes about 2 tonnes of bauxite to produce 1 tonne of alumina; and approximately 2 tonnes of alumina to produce 1 tonne of aluminium as shown in Fig. 9. There is an obvious difference between the two quantities of Bauxite. The quantity of initial Bauxite raw materials depends on the level of impurities and the quality of the materials. They both agree that it's a huge Bauxite raw material quantity.



Figure 9: Process of Aluminium Production (Dubai Aluminium Company Limited 2014).

One can notice the huge decrease in the quantity of material at different stages of the process. Most of the quantities lost are process waste. Particularly, the waste coming out from the refining process is a caustic muddy process waste called Bauxite Residue or commonly known as Red Mud. This alone requires building an engineered landfill that is specially lined to avoid contamination of soil and groundwater.

After the production of Alumina, it is fed directly to specially built aluminium smelters to produce aluminium metal through electrolytic reduction (Hall-Heroult) process as shown in Fig. 10. The aluminium is then withdrawn directly from the hot metal and cryolite bath and poured into casts to make ingots, billets, sow and sheets according to customers' requirements. To support these industrial processes, a custom designed industrial facility should be built and equipped with proper environmental controls. The environmental management of red mud, refinery process and smelting process requires knowledge about the common environmental impacts and the best management practice for such intricate industry (Alcan 1999).

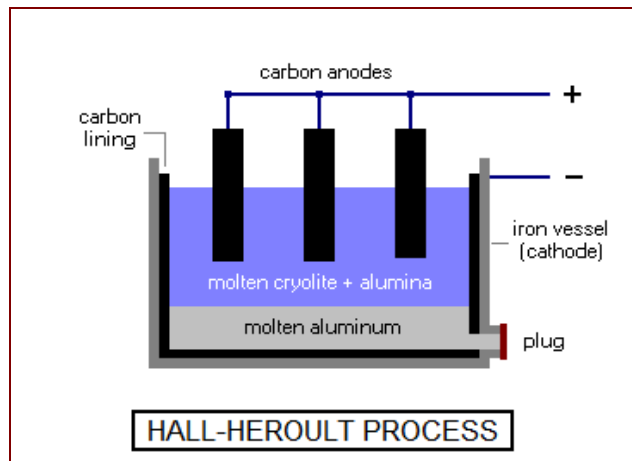
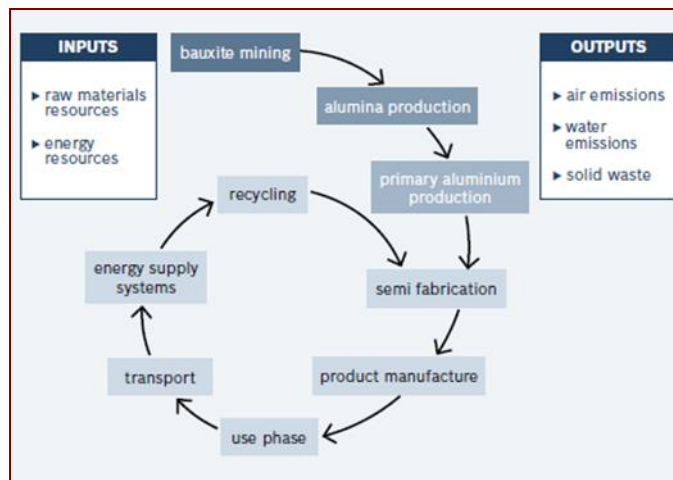


Figure 10: Electrolytic Reduction (Hall-Heroult process) for Production of Aluminium (Matsushima et al. 2006).

### 2.1.3 Aluminium Life Cycle Process

According to International Standardization Organization (ISO) (2014), the life cycle of aluminium products include bauxite mining, Alumina production, primary aluminium production, semi fabrication, product manufacture, use phase, transport, energy supply systems and recycling. Fig. 11 illustrates the stages in aluminium life cycle. The inputs of this process include raw materials resources and energy resources and the output include air emissions, water emissions and solid waste. The ISO 14001 has created a self-management approach by setting

objectives and goals and achieving them while keeping the concept of continuous improvement in the environmental management process.



**Figure 11: Life Cycle of Aluminium Products (International Standardization Organization 2014).**

Aluminium manufacturing process involves dealing with a highly complex industry; which makes the environmental management of such plants a real challenge. This is the main reason behind choosing this industry as an indicator for the environmental management performance in UAE. If environmental management concepts worked well at such complex industrial installations, then definitely it will be regarded as a success. The research will evaluate in depth the efficiency of the Environmental Management System (EMS) in the aluminium industry in UAE.

Tan & Khoo (2005) have conducted an extensive LCA study of primary aluminium supply chain as it consists of a refinery, a smelter and a casting plant. The latter two are available processes in the UAE aluminium industry while the refinery is yet to be built. Through studying the environmental loads of the supply chain processes, it turns out that any small change in the processes within the supply chain can cause significant environmental performance improvements. Tan & Khoo (2005) reach the conclusion that bulk waste, global warming potential, acidification and human toxicity for air have decreased significantly by small percentage of reduction of scrap metal from casting plant, implementation of more sustainable practices at the smelter, reduction of red mud from the refinery and using clean energy production technologies at the power plant.

The environmental burden of a product, process or activity is further studied through the Life Cycle Assessment (LCA) approach by identifying and quantifying the amount of energy, consumed materials and generated wastes released to the environment. The LCA process requires goal, scope definition, life cycle inventory and environmental impact assessment, and interpretation. It is worth noting that there are only few systems and regulations that tackle the life cycle assessment approach in the UAE. A review of the sustainability rules, regulations and rating systems that governs the aluminium life cycle can highlight the strength and weakness of the current used systems. As the LCA approach is useful in accounting for the upstream impacts, it can be suggested as a great tool for impact quantification of the use of aluminium in construction as it tracks the associated environmental impacts from cradle to grave and serves in decision making process. The limitation of this technique is that it requires a great deal of data gathering that is often not released due to confidentiality and information discretion in the company. The use of LCA is further developed into a concept of environmental performance strategy map to overcome the gaps of the current full LCA process. De Benedetto and Klemes (2009) fostered the latter idea where a graphical representation of the sustainable environmental performance indicator is used to find proper balance between cost and environmental impacts such as energy and carbon footprint, emissions, waste, and resource consumption.

Furthermore, the World Aluminium Environmental Metrics Report released in November 2014 explains the life cycle impact assessment for the worldwide aluminium industry in details, using the reference year 2010 data (World Aluminium 2014). The report encompasses an evaluation of the potential environmental and human impacts of environmental resources uses and releases by industrial processes identified during the life cycle inventory. This can be done through several steps that include selection of impact categories such as global warming and further classification and characterization of related data of the impact category. Several related impact categories are, but not limited to, the following: acidification potential, depletion of fossil fuel, global warming potential, water scarcity footprint and ozone depletion potential.

Fig. 12 illustrates the global warming potential split by aluminium manufacturing process type. It is obvious that electrolysis is the highest energy intensive process that produces high levels of greenhouse gases. Due to that and since the UAE currently has aluminium smelters and is yet to construct a refinery in the near future, it is natural to focus on the most significant process that has the highest environmental impact which is the electrolysis process.

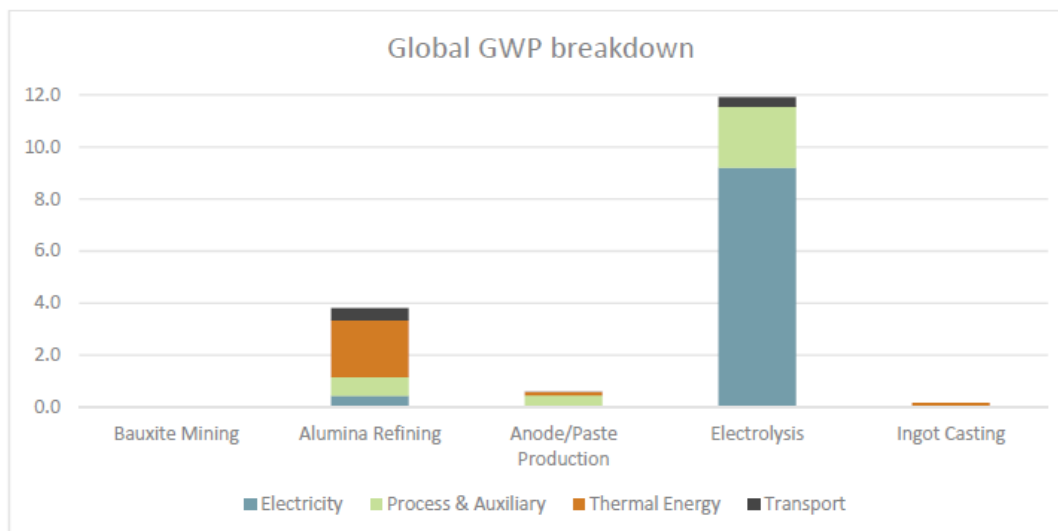


Figure 12: Greenhouse gas emissions split by unit process and process type (World Aluminium 2014).

#### 2.1.4 Aluminium Smelters in the UAE

In the UAE, the main aluminium industry player is Emirates Global Aluminium PJSC (EGA). EGA is a leading producer of primary aluminium located in the UAE with a production capacity of more than 2.4 million tonnes per year. EGA is jointly-held, equal ownership company formed by shareholders Mubadala Development Company of Abu Dhabi and the Investment Corporation of Dubai. EGA has two aluminium smelters located in UAE; EMAL at Al Taweelah – Abu Dhabi and DUBAL at Jebel Ali – Dubai. These two smelter sites are the subjects of the case study conducted within this research. According to EMAL company profile, EMAL alone is one of the largest industrial projects in UAE outside the oil and gas industry. The USD 5.7 billion project in phase I alone, let along the additional 4.5 billion to be invested in phase II, is creating jobs and new opportunities for economic diversification internally and through downstream production (EMAL 2014).

Dubai Aluminium (DUBAL) is an aluminium smelter in Dubai that has a well-established reputation and is supplying aluminium to the Far East, Europe, Asia, the Middle East, the Mediterranean and North America as shown in Fig. 13. It produces high quality aluminium metal as per the customer's specifications. More than 3000 employees work for the company. DUBAL is the seventh largest manufacturers of aluminium in the world with a production of 864 million tonnes in 2011, as can be revealed in Fig.14. According to Dubai Aluminium Company Limited (DUBAL) (2014), the demand for aluminium is huge and it makes sense that a sound

investment would be to enter the aluminium manufacturing sector. But this is not the case as only those who can manage the full production cycle from mining, alumina production to reduction of aluminium can be efficient and more competitive in the global market.

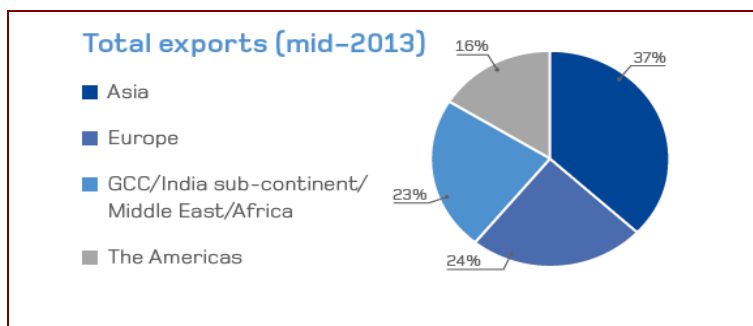


Figure 13: DUBAL's Export Destinations (Dubai Aluminium Company Limited 2014).

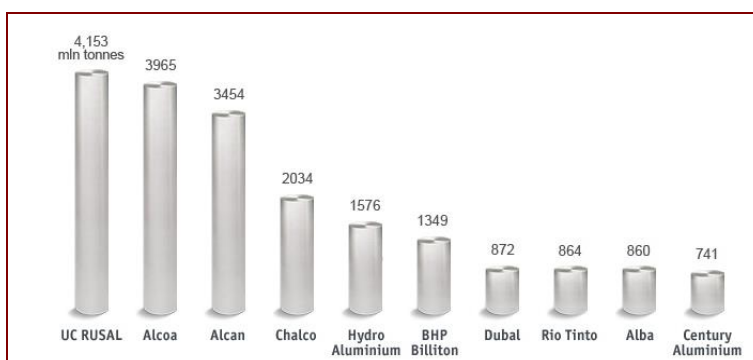


Figure 14: The Ten Big Manufacturers of Aluminium in the World (EGA, 2014).

Emirates Aluminium (EMAL), another aluminium smelter which is located in Al Taweelah-Abu Dhabi, has recently merged with DUBAL to form the new industrial giant Emirates Global Aluminium (EGA). The operations between the two companies have merged to present a new global player in the aluminium production industry. EMAL's ingots, billets and sow are of high quality and are traded on the London Metal Exchange. EGA is the fifth-largest global aluminium company by production after completion of EMAL Phase II in 2014. Hence, the significance of sound environmental performance becomes more vital to ensure a robust global reputation that environmentally promotes the UAE aluminium plants. EMAL phase I and II is set to become one of the largest single-site aluminium smelters in the world (EGA 2014).

To stabilize and secure Alumina price in the region, a new vision came along to establish Shaheen project, the first Alumina Refinery in the region. Alumina is produced from Bauxite and

is directly fed into smelters to produce aluminium. The refinery process will utilize the concepts of the Bayer process to produce high-grade alumina. When developed, Project Shaheen will be owned and operated by Emirates Global Aluminium (EGA) which was incorporated through the Mubadala Development Company of Abu Dhabi and the Investment Corporation of Dubai integrating their respective aluminium interests (DUBAL and EMAL). EGA also owns Guinea Alumina Corporation (GAC), a strategic bauxite mining and alumina refining development project in the Republic of Guinea (EGA 2014). The aluminium production in UAE imports its Bauxite resources from Africa, particularly Guinea.

## **2.2 Regulatory Compliance and the Environmental Management System (EMS) in the Aluminium Industry**

This section explores the development of the Environmental Management System (EMS) and the international treaties supporting EMS. The ISO 14001 EMS is further discussed and compared with other environmental management schemes, locally and internationally. In addition, the efficiency of EMS and the barriers affecting the implementation of EMS are highlighted and discussed through literature review. This provides an overall understanding of the regulatory compliance and EMS in the aluminium industry.

### **2.2.1 The Development of the Environmental Management System**

EMS breaks barriers between departments because it requires input from many departments such as legal, sales and marketing, operations, management, finance and public relations to form its guidelines. It requires collaboration from all relevant department in order to address environmental concerns. Deming mentions that it is a good practice to break down barriers between departments. People in research, design, sales and production must work as a team to foresee problems of production and use that may be encountered with the product or service (Deming 1986).

Fig. 15 shows the Plan, Do, Check, and Act cycle that was developed by Edwards Deming in his book, *Out of the Crisis* (Deming 1986). This conventional approach to Environmental Management System (EMS) implementation was adopted by many environmental management bodies such as the ISO and US EPA. This structure has been debated over literature and there has been some proposal for ensuring quality through behavior based management. Spigener &

Angelo (2001) pointed out that the use of behavior-based method to improve work performance is compatible with the main quality principles. Avoiding blame and focusing on the system instead of the individual, promoting pride in one's work, focusing on system improvements, changing a difficult behavior and enabling pro-quality behavior are all core principles of behavior based management, as stated by Spigener & Angelo (2001). Similar to the EMS implementation, these major principles can be directly implemented to ensure effective environmental management. Deming (1986) though focuses on the systems deficiency problem and mention that 85% of the reasons for failure to meet customer expectations are related to deficiencies in systems and processes, not to the fact that employees are not up to the challenge. In today's world, the adoption of the integrated method would be best to find out the gaps in both the system itself and the how employees implement the system.

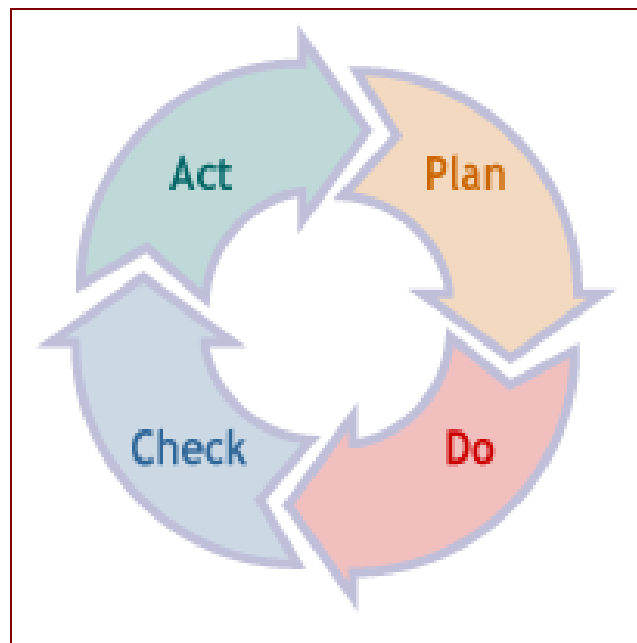


Figure 15: PDCA Cycle (Deming 1986).

Looking back on how the ISO 14000 and its family series such as ISO 14001 and ISO 14004, the EMS standard was first proposed by the British Standards Institution (BSI) group to complement the quality standard. ISO 9001 quality management system and ISO 14001 environmental management systems are correlated and they operate in parallel as the latter arose in favor of the ISO 9001 and to support it directly (Jackson 1997). Therefore, it will be evident through the research that some quality principles will be discussed alongside environmental management due to how closely they work together.



### **2.2.2 International Treaties Related to Environmental Management**

There are several global events and conferences that highlight the significance of environmental management. For example, the United Nations conference on environment and development, also known as Earth Summit or the Rio Conference, was an important conference and has resulted in the formation of later environmental policies and pollution prevention protocols including the Agenda 21 and the framework convention for climate change (Sung 1992). It was evident that indicators for sustainable development have to be in place in order to support healthy and environmental sound growth. In addition, the Kyoto Protocol was a significant treaty extended from the UN framework convention on climate change and it aimed at reducing the greenhouse gases emissions of major industrial countries in the world (Kyoto protocol 2005). More recently, the Paris Agreement (12 December 2015) that aims to hold global warming at below 2 degrees Celsius and limit it to 1.5 degrees Celsius has ambitious climate change reduction targets and is signed by 195 UNFCCC members and ratified by 153 countries (Rogelj, J. et al. 2016). It is clear how environmental management is now acquiring a global significance and how countries are continuously searching for pollution reduction and environmental protection. UAE is a signatory country to most of the above-mentioned treaties and protocols especially Kyoto protocol and the Paris Agreement and it has also ratified the UN framework convention on climate change.

### **2.2.3 The ISO 14001 Environmental Management System**

The main system used to environmentally manage aluminium manufacturing and its related construction industry is the Environmental Management System (EMS) that is detailed in the ISO 14001. This EMS can be considered a voluntary approach to environmental regulation as there is no legal obligation to obtain the certification. The EMS allows the plant operators to work under a systemic framework that regularly monitors, evaluates, keeps records and continuously improves how tasks are performed. According to the International Standardization Organization (ISO), the EMS ensures successful implementation process of all the major elements such as policy setting, planning, implementation and operations, checking and corrective actions, and management review. The system does not only exist on paper, rather, it is present in all audits and inspections, whether external or internal. To be ISO 14001 certified is to

carry a mark of environmental integrity and commitment to environmental excellence (ISO 2014).

Darnall et al. (2008) stated that although the regulatory bodies do not mandate certification to the ISO 14001 Environmental Management System Standard, there are many companies world-wide that voluntarily continue to adopt the ISO 14001 standard. In June 2003, there were 46,836 facilities registered and certified for ISO 14001 and about 25% of these companies were located in Japan. The EMS certification started in the automobile industry and companies such as Ford, Toyota, and Volvo have acquired EMS certification for their businesses. Soon after that, other industries such as the IT and computer solutions industrial sector also adopted the EMS standards, an example of which is Hewlett-Packard (Arimura et al. 2008).

The main drive behind adopting ISO 14001 by these companies is to enhance their environmental image, develop competitive advantage, and be socially responsible. Darnall et al. (2008) confirms that there is cost for certification but the environmental benefits of adopting this system are significant and cover the entire community. Potoski & Prakash (2013) argue that voluntary environmental programs, such as the ISO 14001 Environmental Management System, are considered essential instruments of environmental policy and management at the global scale. They offer a voluntary non-traditional method to achieve environmental governance in a way that complements the regulatory structure as they provide companies with incentives for pollution reduction. The authors claim that ISO 14001 commits the company to adopt best available environmental technologies and assesses environmental impacts of their practices and processes. It also mandates them to train their employees on the Environmental Management System (EMS) and ensures the continuous compliance to environmental standards and regulations. To illustrate this point, Potoski & Prakash (2013) stated that increased levels of ISO 14001 certifications, have decreased the level of air pollutant emissions, particularly SO<sub>2</sub> emissions the more visible pollutant. They concluded that SO<sub>2</sub> emissions were significantly higher in countries with strong economies and lower in countries with more stringent environmental regulations. Grossman & Krueger (1995) agree with this viewpoint and argue that when a country's wealth increase, their pollution level increase up to a certain point. Then, the pressure from their citizens drive the pollution reduction as they demand for a cleaner environment. Darnall et. al. (2008) agrees with the previous authors and has explained the many

benefits the EMS could bring to the industry. She stated that there is potential business value that is generated by adopting comprehensive EMS. The author presented evidence that supported this argument and claimed that facilities that adopt EMS will benefit financially.

Despite all the benefits that the ISO 14001 Environmental Management System (EMS) Framework offers, there is an on-going debate in literature about the effectiveness of this voluntary approach in managing environmental issues of the plant. Ziegler and Rennings (2004) reported that in German companies, being EMS certified does not directly affect the environmental performance. In addition, King and Lenox (2000) presented an argument suggesting that industry self-regulation by using voluntary approaches for environmental management is difficult without sanctions. They raised the question of whether profit making industries can have effective environmental management by using the voluntary approach to environmental regulation. They concluded that it is difficult to establish and maintain industry self-regulation programs such as the ISO 14001 EMS particularly due to elevated poor environmental performance of industry. When the regulation comes from within the company or the industry itself, it is often not taken seriously. It takes a strong regulator to enforce environmental regulations; otherwise, self-commitment of the environmental management may have its downsides including producing biased and false information about the industry environmental performance, especially if the regulation comes from within.

To summarize, the main shortcomings of the current Environmental Management System (EMS) system is its inability to effectively manage environmental issues and concerns of the industry. This can be attributed to the following three defects: organizational, system and human aspects. Unskilled labor, weak management commitment and poor standards are the main problems in the implementation of the EMS system. On paper, the EMS may seem as a powerful tool for effective environmental management; however, the system is what we call a “paper tiger”. Ample papers support the EMS but, there is no implementation of the EMS (Zackrisson et al. 2000). It is evident that green economies and integrated environmental performance is the future for industries and those companies which cannot keep up with the advance of the integrated environmental management will no longer exist.

There is certainly a lack in standardized environmental performance reporting system or format, according to Montabon et al. (2006). The authors stated that there are many challenges in measuring and reporting environmental data due to their complexity, the type of environmental

impacts of the business itself, interpretation of this impact in monetary value or weighing it against the profit, and lack of unified system for reporting and measurement although there are plenty of guidelines established. Furthermore, the readiness, validity and quality of environmental data are usually a concern especially because many companies refuse to disclose such data due to its potential adverse effect on their reputation and corporate image. This is true for almost all industries including the aluminium industry.

There are a number of initiatives that have been developed to standardize environmental performance reporting of the industry and they include the following: Measuring Environmental Performance of the Industry (MEPI), Global Reporting Initiative (GRI) and Global Environmental Management Initiative (GEMI) (Montabon et al. 2006). On the other hand, Arimura et al. (2008) stated that companies now publish their environmental reports to enhance communication with their investors, regulators, stakeholders, customers and the community in which they operate in. The process of measuring environmental performance is usually a complex task as it requires integration of quality and quantity elements and describing environmental aspects, impacts and mitigation measures, in which sometimes these elements cannot be quantifiable and measured by tangible means.

#### **2.2.4 Comparison Between Existing Systems for Environmental Management**

According to the National Science Foundation (2001), the key components of the Environmental Management System (EMS) are listed below; however, some references list initial review as the first step to determine the environmental aspects and impact associated with the company's activities:

1. Setting, developing and implementing an environmental policy
2. Planning through setting up objectives and targets, establishing environmental aspects and attributes, legal requirements and setting up required actions
3. Implementation through structure and responsibilities, training, communication, documentation, and emergency preparedness
4. Checking and corrective actions through monitoring and measurements, corrective and preventive actions, records, inspections and audits
5. Management review process that reviews the EMS while focusing on continuous improvement

These steps are translated differently in both ISO 14001 and the EMAS systems. The main similarities and differences between the two systems are explained in Table 3. It is evident that both environmental management systems are voluntary; however, the ISO 14001 is more common and spread out according to Arimura et al. (2008) while the EMAS system is more stringent and location specific.

**Table 3. Main differences between EMAS and ISO 14001 (European Commission 2011).**

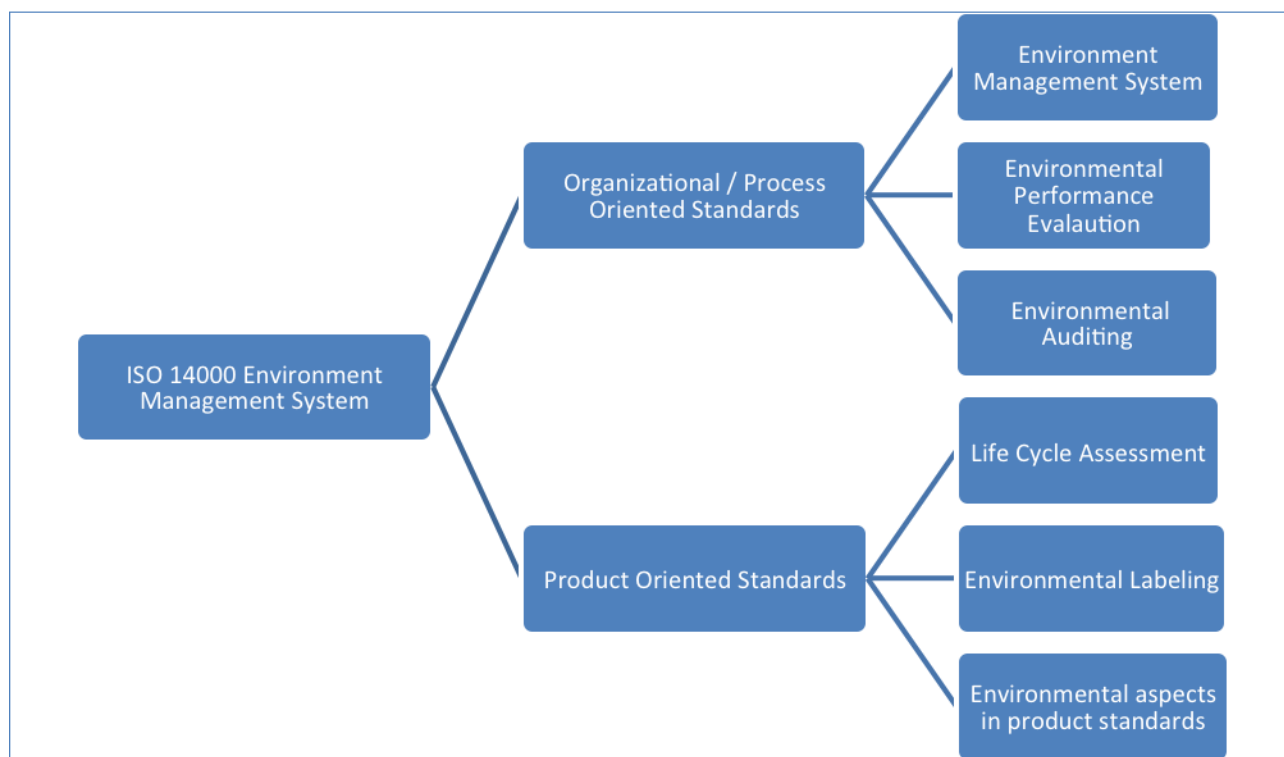
Elements	EMAS	ISO 14001
<b>General aspects</b>		
Legal status	• European Regulation (EC) No 1221/2009	• International, commercial standard under private law
Participation	• Voluntary	• Voluntary
Geographical Outreach	• Globally applicable	• Globally applicable
Focus and objective	• Focus on continual improvement of environmental performance of the organization	• Focus on continual improvement of the Environmental Management System
<b>Planning</b>		
Environmental aspects	• Comprehensive initial environmental review of the current status of activities, products and services	<ul style="list-style-type: none"> <li>• Requires only a procedure to identify environmental aspects</li> <li>• Initial review is recommended, but not required</li> </ul>
Legal compliance	• Proof of full legal compliance is required	<ul style="list-style-type: none"> <li>• Only commitment to comply with applicable legal requirements</li> <li>• No compliance audit</li> </ul>
Employees involvement	• Active involvement of employees and their	• Not required (ISO 14001 and EMAS both foresee

	representatives	training for employees)
Suppliers and contractors	<ul style="list-style-type: none"> <li>• Influence over suppliers and contractors is required</li> </ul>	<ul style="list-style-type: none"> <li>• Relevant procedures are communicated to suppliers and contractors</li> </ul>
External Communication	<ul style="list-style-type: none"> <li>• Open dialogue with external stakeholders is required</li> <li>• External reporting is required on the basis of a regularly published environmental statement</li> </ul>	<ul style="list-style-type: none"> <li>• Dialogue with external stakeholders not required</li> <li>• External reporting is not required</li> </ul>
<b>Checking</b>		
Internal environmental auditing	<ul style="list-style-type: none"> <li>• Environmental Management System audit</li> <li>• Performance audit to evaluate environmental performance</li> <li>• Environmental compliance audit</li> </ul>	<ul style="list-style-type: none"> <li>• Includes only the Environmental Management System audit of the requirements of the standard</li> </ul>
Verifier/Auditor	<ul style="list-style-type: none"> <li>• Environmental verifiers are accredited/licensed and supervised by governmental bodies</li> <li>• Independence of the environmental verifier is required</li> </ul>	<ul style="list-style-type: none"> <li>• Certification bodies are accredited through a national Accreditation body</li> <li>• Independence of the auditor is recommended</li> </ul>
Audits	<ul style="list-style-type: none"> <li>• Inspection of documents and site visits to be carried out according to Regulation</li> <li>• Check for improvement of</li> </ul>	<ul style="list-style-type: none"> <li>• No certification rules in standard (other standards for auditing and certification)</li> </ul>

	environmental performance • Data from environmental statement needs to be validated	• Check of Environmental Management System performance, but no frequency specified or required
Derogations for SMEs	• Extension of verification intervals from three to four years • Updated environmental statement needs to be validated only every two years (instead of every year) • Environmental verifier takes into account special characteristics of SMEs	• No derogations foreseen
Official registration by authorities	• Publicly accessible register records each organization • Each registered organization receives a registration number	• No official register
Logo	• Yes	• No

Cascio (1996) mentions that pertaining to ISO 14000 series, two main categories are explained, as show in Fig. 16. The first category is concerned with process and organization standards and the second is related to product oriented standards. ISO 14001, which is concerned with environmental management, focuses on the first category and organizations can often be certified with it. As the Environmental Management System (EMS) certification is voluntary, it is designed to improve the environmental performance beyond regulatory requirements and ensures continuous improvement. Most of the interest in EMS is mainly linked to certification as it reflects sound environmental practices that influence company branding. Therefore, the interest lies in the first category related to EMS, auditing and performance evaluation. In fact, a

sounder approach to a holistic aluminium product analysis would be to reinforce the involvement of the industry in the second category of EMS relating to life cycle assessment and environmental labeling. Since the management sees no profit in the second category (their role is limited to manufacturing process and delivering the product), efforts remain sparse in regard to proper product handling, post manufacturing processing and end of life conditions (Moors 2006).



**Figure 16: Organizational / Process Standards vs. Product Standards (Cascio 1996).**

For the purpose of comparing the local AD EHSMS standard with international standards such as EMAS and ISO14001, the Abu Dhabi Environment, Health and Safety center (OSHAD 2012) mentions that AD EHSMS includes the key elements of all related EHS standards such as the ISO 14001, ISO 9001 and OHSAS 18001. However, AD EHSMS has mandatory system elements for all entities operating in the Emirates of Abu Dhabi. In addition, for the purpose of establishing AD EHSMS, the integration of environment, health, safety and risk elements is also required. The AD EHSMS should be approved by the sector regulatory authority or the competent authority and it does not require certification to international standards. Entities should report on quarterly basis to the sector regulatory authorities. Auditing EHSMS should also be conducted on an annual basis by third party registered auditors. AD EHSMS focuses



more on health and safety aspects rather than environment, even though environment aspects are included in the system. Other environment regulatory bodies in the Emirate, such as the Environment Agency-Abu Dhabi, tackle the environmental assessment of projects more closely.

### **2.2.5 Barriers to the Implementation of the Environmental Management System (EMS)**

Some of the key barriers to proper implementation of the Environmental Management System (EMS) are communication gaps, lack of resources whether human or financial, along with the proper understanding of how EMS is integrated with the company's operation (González 2004). This is especially important for the aluminium industry, which contains environmental risks and hazards in almost every process operation or step, the EMS should be fully present to assure environmental sound practices are occurring and minimize environmental risk and hazards.

Some companies tend to get certification for the Environmental Management System (EMS); however, others fail to focus on this certification. The main reason behind this is that management systems guarantee receiving these certifications without maintaining adequate environmental performance. Hence, one faces another gap reflecting on EMS as a system. On numerous occasions, upon auditing big industrial companies, it may seem that the company is doing well environmentally speaking yet a sound environmental performance is often visible only on paper. Management commitment towards environmental responsibility is another challenge in this part of the world. The management often is ambitious and sets high level business targets that may not include environment in their prospect. Sometimes, environment is included in the agenda but at a lower priority than other profitable elements of the project. This puts the environmental professionals in a real conflict between doing their job in monitoring the environment and following the company's profit-making direction. This does not necessary mean that the environmental professional shall become an advocate for the environment; however, it only means that environmental considerations should be there in the big picture during planning for industrial mega-projects to avoid increased cost and decrease post construction efforts. Fig. 17 and Fig. 18 are excerpts from a study conducted about motivation and barriers of implementing the EMS system in Spain. The example taken represents the energy

sector and some external and internal factors that affect the EMS implementation in energy related companies are listed (González 2004).

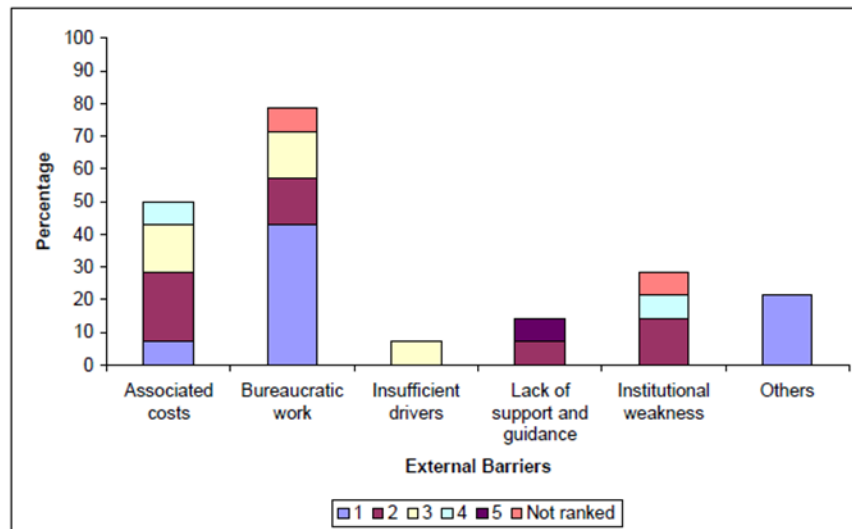


Figure 17: External barriers by the 14 organizations from the energy sector (González 2004).

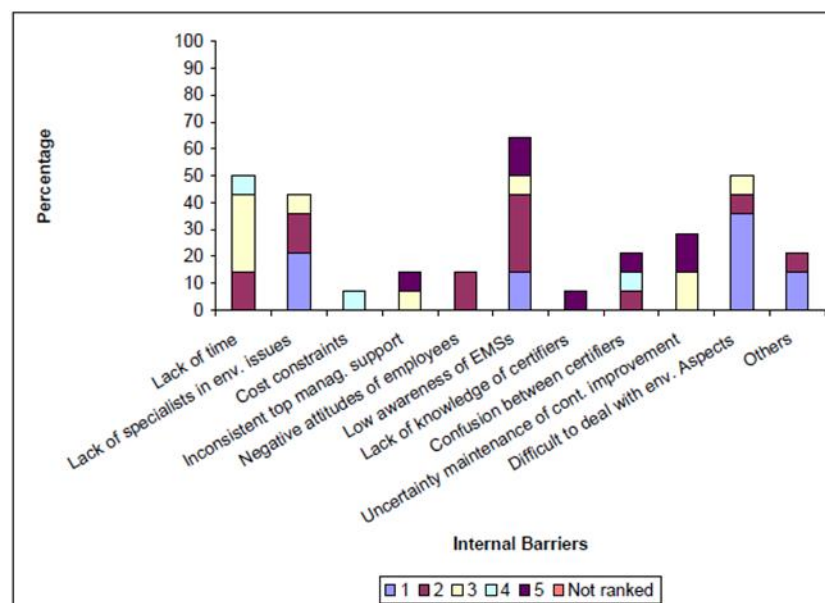


Figure 18: Internal barriers by the 14 organizations from the energy sector (González 2004).

It can be inferred that the main external factors affecting the implementation of the Environmental Management System (EMS) are bureaucratic work and associated cost, whereas the main internal factors are low awareness of the EMS, lack of time and specialized human resources and difficulties in dealing with environmental aspects.

Another study about the barriers to implementation of EMS in construction industry in Ghana suggested a different approach to determine the barriers of EMS. Ayarkwa et al. (2010) measured the opinions about the main EMS barriers in the construction industry contractors, consultants and clients. The main barriers were the top 4 which are lack of knowledge in the industry, increased cost, and reluctance to change traditional practices due to disruption and high cost and finally shortage of personnel as shown in Table 4.

**Table 4. Barriers to Implementation of ISO 14001 EMS in Ghanaian Construction Industry (Ayarkwa et al. 2010).**

Barriers to implementation of ISO 14001 EMS in Ghanaian construction industry – Ranked Based on Significance (where 1 is most significant and 3 is least significant)			
Barriers	Contractors	Consultants	Clients
Lack of knowledge in the Industry	1	3	4
There will be increased cost	2	1	3
Reluctance to change traditional practices due to disruption and high cost	3	4	1
There is shortage of personnel	4	2	2
It will be in conflict with company's objectives	5	7	9
Lack of client support	6	9	-
The companies' employees will resist it	7	5	6
Lack of government support	8	6	5
The company will lose its competitive edge	9	8	8

The list of barriers to the Environmental Management System (EMS) is extensive but there are benefits too in implementing the EMS and mostly these benefits include ensured regulatory compliance, cost savings, employee welfare, improved competitive advantage and improved trade through sound environmental reputation. The system also allows putting environmental related actions in an integrated framework that is monitored and fully reviewed periodically.

## **2.2.6 The Efficiency of the Environmental Management System (EMS)**

The efficiency of environmental management can be examined through performance indicators. The Finnish Environment Institute conducted a survey on the environmental

efficiency assessment methods and indicators. Through their findings, Sorvari et al. (2011) identified 25 environmental performance indicators in four categories:

1. Compliance: notices of violation, fines, exceeding and incidents
2. Environmental releases: including releases to air, water, land and environment
3. Resource consumption: thermal energy, electricity, water consumption and paper purchases
4. Environmental remediation: number of remediation sites and risk factors

On the other hand, the indicators of sound environmental management as per Japan's Ministry of Environment include the following (Ministry of Environment, Japan Government 2003); technologies for environmental protection, research and development for the Design for the Environment (DfE), environmental accounting, green purchase, environmental communication and partnership, compliance to environmental laws and regulations, and safety, health and social contribution concerning the environment.

Countries such Japan and Finland have an efficient EMS due to the healthy practices and measures that are taken in the production stage. However, these two countries are different in their choice of EMS performance indicators types. The difference of the indicators type can reflect on the manufacturing process and can tell us what is considered of value environmentally in both countries. To explain, the environmental protection technologies are of great value in Japan that is placed at the top of the indicators. However, environmental compliance is of premium importance in Finland because EU environmental regulations are robust and stringent and compliance is essential to most European countries. In general, the indicators can be used by the industry or the business organization in order to assess their environmental management and performance as well. One of the key components that keep coming up is environmental communication. This is a vital component and its efficiency indicate the success of any management system. Keeping healthy channels of communication between all staff is essential in closing this gap; especially in this culture of multi-national diversity. Another main purpose of these indicators is to measure and evaluate environmental burdens and environmental problems that need to be solved and determine the adequacy of environmental efforts.

According to Global Environmental Management Initiative (GEMI) (1998), 41 companies participated in an environmental management survey in 1995, listing the indicators of common use (Table 5). It can be noticed that the key indicators are the number of recordable

injuries, lost workday cases, amount of hazardous waste generated and quantity of toxic chemicals releases.

**Table 5. Examples of Companies using Measures (Global Environmental Management Initiative (GEMI) 1998).**

<b>Measure</b>	<b>Number of companies using measure</b>
Number of recordable injuries/illnesses	33
Number of lost workday cases	33
Amount of hazardous waste generated	31
Quantity of toxic chemicals released	25
Number of notices of violation	23
Type/volume of non-regulated materials recycled	22
Type/volume of non-regulated materials disposed	21
Amount of dollar fines	21
Number/type of reportable releases	21
Permitted air emissions	18
Amount/type of fuel used	18
Amount of water used	16
Total annual EHS operating costs	15

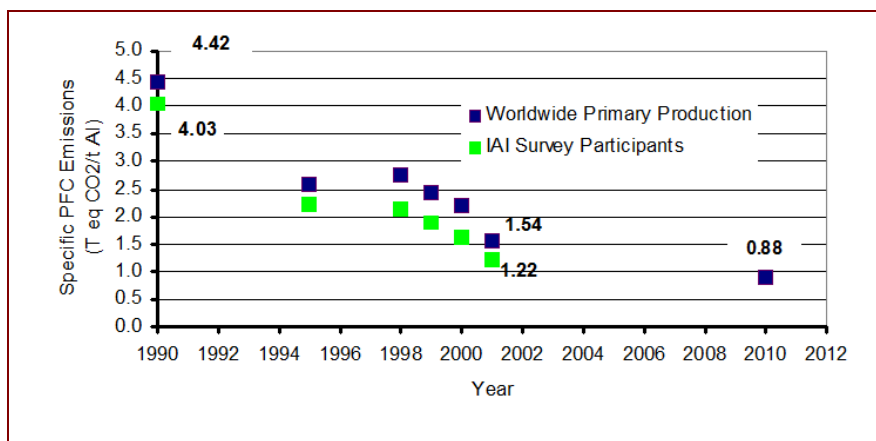
Global Environmental Management Initiative (GEMI), 1998, classifies indicators into two main types: leading and lagging. Leading indicators are usually in process or management indicators and can be either qualitative or quantitative. Examples of such indicator are number of training and tool box talks conducted, number of community outreach initiatives and certification under ISO 14001. The leading indicators reflect current rather than past performance but they may not address stakeholder's concerns causing them to be difficult to quantify and evaluate.

In contrast, lagging indicators are end of process or output indicators and they are usually quantitative. Examples of such indicators include amount of emissions to air or amount of waste generated. The lagging indicators are easy to quantify and understand and they are preferred by public and regulators. They take time to be generated, hence came the name "lagging", and the root causes are not identified. Usually, most companies use a combination of both leading and lagging indicators to describe environmental management performance.

For the purpose of this research, the focus will be confined to evaluating environmental management in the aluminium production industry and some selected tools and indicators that

help in managing the environmental issues. The research will not delve into explaining the role and efficacy of all the indicators mentioned above.

The International Aluminium Institute (IAI) has set the global aluminium sustainable development initiative. The 25 member countries representing world leaders in the aluminium industry committed to eight voluntary objectives and measured 22 key performance indicators. Both EMAL and DUBAL, EGA subsidiaries, are member companies of the IAI. The IAI environmental performance indicators include the global PFC emissions, aluminium shipment to transportation sector, total aluminium recycled, fresh water consumption per tonne of aluminium produced, global percentage of plants with ISO 14001 or EMAS certification, global SO<sub>2</sub> and particulate emissions, global fluoride emissions, global energy use and consumption, tonnes of Bauxite residue deposited per tonne of alumina produced and global GHG emissions (CO<sub>2</sub> equivalent). According to the Global Aluminium Sustainable Development Initiative (2003), the recent achievement in the aluminium production sectors include a 70% reduction in specific PFC emissions through 2001 from the 1990 baseline as shown in Fig. 19. This is only one example of the many achievements at the global aluminium environmental sustainability performance.



**Figure 19: Reduction in PFC Emissions (Global Aluminium Sustainable Development Initiative 2003).**

To examine environmental management of aluminium industry related mega-structures, one can look at world-wide case studies that shed light on the environmental management of the plant. According to the Pulitzer Center on Crisis Reporting (2011), the Ajka Alumina plant accident in West Hungary is an industrial accident that destroyed human lives, homes and entire ecosystems. One of the dams holding the liquid waste of red mud collapsed resulting in the flooding of the village. In this accident, 10 people died and 150 people were injured. The

incident resulted in formation of contaminated land that is no longer fertile due to the alkalinity of the red mud liquid waste.

Though no clear indication exists on the real cause of the accident, human error is stated to be the main cause. That is, 50 m breach occurred in the dam wall which points at a design fault. Moreover, the wet-technology used in the factory to produce alumina was outdated that did not fully treat the process waste to an acceptable and safe level. Environmental conditions and heavy rain in that period only worsened the situation. The investigation was focused on the legal environmental status of the factory and the deficiencies of the permission and supervision process in the aluminium factory. Following this accident, some EU laws were amended and a better implementation of these laws and management standards was established. Nonetheless, proper environmental planning and management from the early design stage could have prevented this disaster. Environmental assessment of the impacts would have contained scenarios of spills and formed a proper mitigation plan in such case. The absence of integrated model for environmental management causes major gaps which usually manifest as operational faults.

In UAE aluminium production and construction related industry, the environmental policy is incorporated and embedded in the environmental, health and safety (EHS) policy of the company. An example of the EHS policy in EMAL aluminium smelter is as follows:

- All employees are authorized to refuse to perform any act they judge to be unsafe.
- No employee may be instructed to perform an unsafe act or work in breach with this policy.
- All employees are required to stop any activity that they judge is unsafe or in breach of EMAL policy.
- No employee shall incur any punishment or suffer any negative consequences as a result of following this policy.
- No employee or contractor is permitted to act in breach of this policy and any such occurrences may lead to disciplinary measures being taken against those accountable for the breach.

One can notice that the focus of the EHS policy is on health and safety aspects rather than environment aspects. The main reason for this is that work culture favors these elements over the environment because of their visibility and direct impact. In reality; however, one cannot separate health and safety from the environment because the human element is an integral part of

the environment. As such, their safety and health represents a healthy environment in which they can work and operate in.

There are local environmental standards in Abu Dhabi such as Abu Dhabi Environment, Health and Safety Management Systems (AD EHSMS) which encompasses health and safety elements alongside the environmental elements (OSHAD 2012). As mentioned above, the EHS elements work in an integrated way but the focus of this research will be on environmental management elements with attention on environmental sustainability indicators.

According to Rowland-Jones et al. (2005), the current environmental management systems applied in organizations, whether they are BS EN ISO 14000:1996 or EMAS does not directly comment on the environmental performance. Since environmental management is the control of all human activities that have a severe impact on the environment, these standards do not comment on the extent of the controls applied, the methodology or approach exercised or the effectiveness of this control or mitigation measure.

Effective implementation of the Environmental Management System (EMS) will assist in eliminating and reducing risk factors that cause environmental accidents and catastrophes in industrial plants. It is useful to assess the EMS requirements to ensure continuous improvement of EMS practices at the organization. Environmental management at industrial projects should be closely integrated in the process operations, management requirements and work culture. This would generally require working at different levels such as the individual level, organizational level, and management level. Awareness of the EMS performance related factors certainly plays an essential role in the successful implementation of EMS standards and reflects directly on the reputation of the facility. Finally, improving the EMS at industrial projects guarantees sound production, related construction and operation practices (Chen & Yang 2004).

### **2.3 Literature Review Summary**

As explained, the literature review provided information on the global perspective of the aluminium industry along with a description of the major aluminium industry players in the UAE. In addition, it has provided solid background on the Environmental Management System (EMS) and the factors affecting its implementation, which form the basis of the study methodology choices. The following chapter discusses the methodology of this research study in-depth and explores several methods for data collection and analysis.



## Chapter 3: Research Methodology

### 3.1 Description of Research Methodology

Referring to Table 2 where the study objectives are mapped to specific methods, the research methodology follows a step-wise approach where each method is dependent on the results of the previous method. Fig. 20 illustrates the Concept Mapping Approach that is used to determine the linkages between the study objectives and the chosen methodologies.

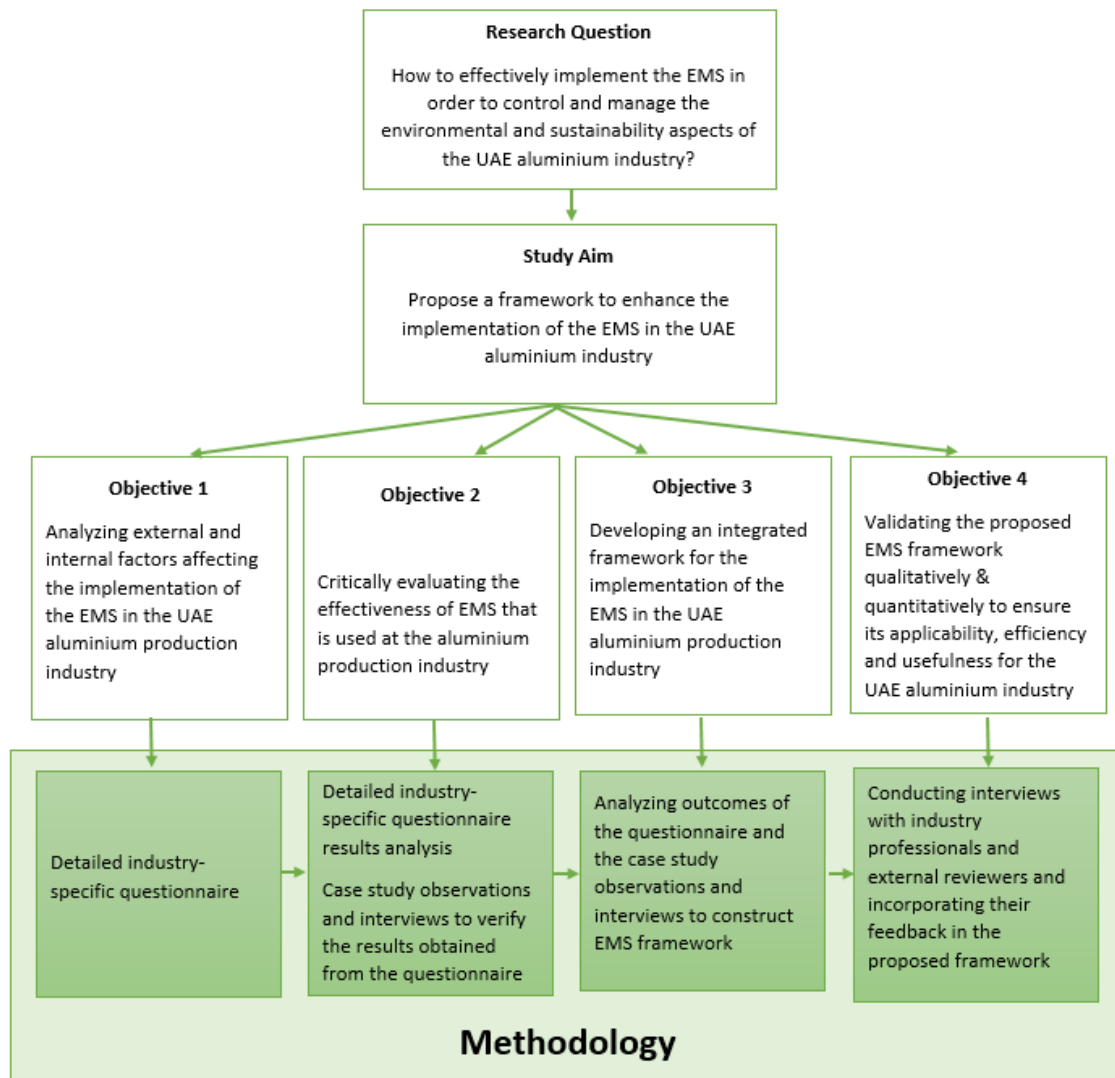


Figure 20: Concept Mapping Approach to Map Study Question, Aim, Objectives with Methodology

It is then proposed to first conduct an industry-specific questionnaire to gather primary data about the factors affecting EMS implementation in UAE aluminium industry. Second, case study observations and interviews are conducted to verify the results obtained by the questionnaire. In fact, the structure of the interviews questions are based on the findings of the questionnaire. Third, upon results analysis of the questionnaire and the case study, a framework is developed based on the gaps found during results analysis. Finally, a series of qualitative and quantitative validation steps of the conceptual framework are performed to reach the final framework output.

Studying the environmental factors that affect the implementation of the Environmental Management System (EMS) helps regulators, owners, management and end users to shed light on the existing EMS practices and understand their weaknesses and strengths. Integrating environmental factors into the EMS design requires some preliminary studies such as defining performance indicators, determining environmental standards and collecting environmental performance data. Regardless of what type of Environmental Management System (EMS) is used at the industrial facility, whether ISO 14000, local EMS or a combination of both, these EMS share similar core requirements such as environmental policy, planning, implementation, risk assessment, auditing and monitoring, continuous improvement, management commitment and review. After addressing these requirements, it will be more visible to determine the weakness in the implementation of the EMS.

The investigation includes examination of the factors affecting the assessment and improvement of environmental management requirements in the aluminium production industry by a questionnaire and a case study. Environmental Management System (EMS) factors can be ascertained through EMS performance evaluation and identifying areas of strength and weakness. Both in the questionnaire and case study, management reactive and proactive methods for successful implementation of the EMS will be discussed. Moreover, in the case study, change management and factors affecting organizational structures are also considered in terms of how sound the EMS is. Consequently, the environmental management evaluation process will identify several elements for successful implementation of the EMS.

According to Taylor et al. (1987), there are three main factors affecting the environmental management in industrial projects: human factors such as skilled and trained

labor, organizational factors such as management commitment and work environment and system factors such as used standards and management systems.

Human factors affecting the Environmental Management System (EMS) include human failures, accident management, stress and fatigue management, welfare, labor environmental competence and skills, frequency of maintenance, inspections and testing, inefficiency and work demand management, and staff management at the industrial facility (Laurence, 2005). Additionally, organizational factors affecting environmental management include organizational changes and EMS work culture, lack of management commitment and awareness about EMS procedures, work patterns and types of resources available, communications in the organization, and leadership and management styles. Finally, system factors affecting the EMS include the type of EMS procedures used at the facility, strengths and weaknesses of the EMS standard, reporting and communication techniques, control measures and the limitation of the physical environment. Each of those factors will be undergo in-depth analysis using different assessment and evaluation techniques. EMS related case studies of aluminium industrial projects around UAE will be discussed further.

Measurement and improvement of environmental performance data and environmental management efficiency has been assessed through benchmarking process. Environmental Benchmarking has been undertaken through comparing environmental performance elements contained in the company sustainability reports with environmental best practice at leading aluminium industries of the world such as UC RUSAL, as investigated by section 1.5.1 Environmental Performance Comparison. Then, best management practice for the environmental sustainability of the aluminium industry is discussed. Gap analysis has been performed to determine the gaps existing in UAE aluminium production industry. Resource conservation and pollution prevention methods will be further investigated to complement the best management practice.

Post analysis, a framework for implementing the Environmental Management System (EMS) in the aluminium production industry will be established based on analysis of the study objectives, the questionnaire results and the case study. This will help enhance the overall understanding of the environmental management in the aluminium industry and will ensure a better implementation of such management systems. The framework will be validated qualitatively and quantitatively by industry experts and external reviewers.

### 3.2 Justification for Selecting Research Methodology

For the purpose and the objectives of this study, primary and descriptive research methods are both employed. According to Glass (1976), the primary research usually contains the original analysis of data in a research study. It also includes the application of statistical methods as what is conducted through the questionnaire part of this study. Descriptive research describes the characteristics of a population with regards to specific topic. According to Knupfer and McLellan (1996), descriptive research does not fit into the definition of qualitative or quantitative research methodologies but instead it utilizes elements of both. This is what has been conducted through the framework validation step of the study where elements of qualitative and quantitative research are employed. Descriptive research is often concerned with the type of the research question, which is in this case how efficient is the Environmental Management System (EMS) in controlling the environmental and sustainability impact of the aluminium industry in the UAE. The main purpose of research is to describe, explain and validate findings.

Based on the research objectives prescribed within this study, a combination of both phenomenology and ethnomethodology general approaches are typically used. The research objectives include identification of external and internal factors affecting the implementation of the Environmental Management System (EMS) and evaluating the effectiveness of the EMS. In addition, developing an integrated framework to enhance the implementation of EMS and validating this framework quantitatively and qualitatively. As such, an industry-specific questionnaire is conducted followed by case study observations and interviews to verify findings and confirm conclusions obtained through the questionnaire. By analyzing these research objectives, it can be deduced that elements of phenomenology and ethnomethodology are utilized. According to Porter (1998), phenomenology is used to describe how individuals experience a phenomenon and construct a common understanding of it, as the name implies. In the case of this study, the descriptive type of research methodology that is applied throughout the research and focuses on understanding of the Environmental Management System (EMS) within the aluminium industry follows the phenomenology concepts. While ethnomethodology is concerned with methods used to produce a social order and a practical research strategy as explained by Heritage (2013). To further illustrate, the ethnomethodology concepts within this study can be dissected as follows: the aluminium industry community represents the socio-

cultural group as the word “ethno” implies. The practices used by aluminium industry managers and operators represent the “method” and the systematic description of these practices refers to the “ology” within ethnomethodology concepts. Then, the systematic description of the practices conducted by the aluminium industry community follows an ethnomethodology approach. Therefore, to understand and describe the processes of EMS in UAE aluminium industry, a combination of ethnomethodology and phenomenology research approaches is used.

In summary, to understand the condition of the Environmental Management System (EMS) in the UAE aluminium industry, a research questionnaire followed by case study observations and interviews are used. The results of the questionnaire and case study are further used to build a framework for efficient EMS implementation in the aluminium industry.

### **3.3 Questionnaire Structure and Design**

There are two major smelter plants in the UAE focusing on the upstream aluminium industry, located in Al Taweelah and Jebal Ali sites. The population of the questionnaires is comprised of two categories: firstly, top management which includes directors, managers and senior engineers, and secondly, operational laborers. Due to the limited education of the operational laborers, there was a need to conduct targeted workshops that explain the purpose, structure, and the mechanism of the research questionnaire.

The questionnaire, included in appendix A of this study, begins with demographic questions such as job position, age, gender and education level. Such questions help recognize the employees’ profile and their background. An example of demographic questions is as follows:

Q1. Which Department do you work in?

- Management/ Senior Engineer
- Manufacturing /Operations
- Others

This question help divides the population into two main groups, management and senior engineers as group 1 and manufacturing and operational staff as group 2. Following this, general statements about the Environmental Management System (EMS) status were examined and

validated through a Likert scale system that provides the respondents with a chance to express his/her interpretation of the statement.

An example of an EMS evaluation question is as follows:

<i>No.</i>	<i>Questions / Opinions</i>	<i>Strongly Disagree</i>	<i>Disagree</i>	<i>Agree</i>	<i>Strongly Agree</i>	<i>Don't Know</i>
-	The facility conducts regular annual environmental training for the staff	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

According to Leedy and Ormord (2010), the Likert scale is highly effective in measuring the implementation of any system because it presents the individual attitude and behavior towards the scheme. The general statements contain elementary information about the EMS that all employees should be aware of in the smelter plants and understand their mechanisms in the operational processes. For instance, the general statements section focuses on the level of the EMS awareness inside the facility and among the employees by highlighting that the accessibility factors are considered vital elements for EMS implementation. Then, the questions examine the organizational control of EMS inside the facility that can be applied by proper documentation of policies, objectives, and procedures. Moreover, this section covers the management commitment towards providing the required competencies for their employee through training courses, workshops, and seminars in order to facilitate their understanding of the importance of EMS and why it should be applied in the aluminium upstream industry. To do so, all responsibilities should be clearly defined for all the employees, which the EMS section of the questionnaire aims to check. By achieving this, the communication channels internally between the departments or externally with federal government bodies will be visible thus allowing the employee to monitor and implement EMS effectively. In addition, this section explores the efficiency of the environmental social role of the organization (Corporate Social Responsibility) and the programs, which are implemented to increase the level of EMS awareness and reduce the environmental impacts that may concern the stakeholders.

After examining the technical aspects of the Environmental Management System (EMS), the questionnaire in the next section starts using an opinion based evaluation approach to determine the employees' beliefs regarding the strengths and weaknesses of EMS

implementation in aluminium production operational processes. That is, the questionnaire tries to observe the EMS value from the employees' perspective and this can vary from one employee to the other since it includes different aspects such as behavioral and managerial skills. An example of an opinion based question is as follows:

To what extents have each of the following groups influenced your facility to improve environmental performance?

<i><b>Groups</b></i>	<i><b>Low Influence</b></i>	<i><b>Medium Influence</b></i>	<i><b>High Influence</b></i>
<i>Regulators</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>Customers</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>Local community</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>Shareholders</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>Competitors</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>Media</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>Suppliers</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>Environmental Groups</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

This question helps define the most influential groups in improving the environmental performance of the aluminium industry in the UAE. Another example, one of the questions closely examines whether the employees, managers or operational labors believe that implementing EMS effectively will help the organization improve their project management practices. Then, the employees are asked about the strengths and efficiency of the EMS regulatory system, the level of compliance and respective attitudes of management and operational employees towards this system. This will help identify if there are any behavioral or cultural issues beside the technical or procedural factors that can affect the EMS implementation in aluminium production process. According to Matuszak-Flejszman (2011), there are several internal and external factors that directly influence the EMS system implementation. Exposing these factors is essential to manage their effects on the EMS system. As such, the questionnaire strives to evaluate the external factors such as lack of standards and laws that support the EMS enforcement from the employee perspective and then the same concept will be applied for the variety of internal factors e.g., absence of resources, competence, and knowledge.

### 3.4 Questionnaire Data Collection

Primary and descriptive research methods are used in which data is collected through going on-site and personally collecting responses on the questionnaire. An estimated population number was determined to enable the calculation of an optimum sample size for the questionnaire. The sampling method chosen for this research is the stratified random sampling method that enables the population to be divided into groups; management staff and labor staff. For instance, Hofmann & Stetzer, (1998) suggest using the stratified random sampling method because it provides a varied cell that contains different construction roles: Managers, Engineers, Foremen, etc. The authors believe that this statistical mechanism provides accrued outputs and examinations for the desired population. In addition, Sarkar et al. (2015) mentions stratified random sampling method is one of the best statistical approaches to sampling in environmental management due to its many advantages. As per the authors, the stratified random sampling method can present large, different units of the desired population required in environmental management due to its diversity elements. This, in turn, will save money and time for field experiments. It also presents an advantage as the measurements within strata have lower standard deviation and therefore can achieve lower percentages of error; in addition, measurements as more manageable within strata. According to the authors, for this reason many scholars consider it the most common and appropriate statistical approach for the Environmental Management System (EMS) studies.

Random samples from within each group were selected. Under the 95% confidence interval for a population of about 6750 employees and a margin of error of about 5%, a representative sample size was calculated to be around 364 employees. The actual gathered responses were obtained from 371 employees. As explained above, the questionnaire had three main sections which are demographic section, Environment Management System (EMS) evaluation through Likert Scale System, and lastly, the opinion based EMS evaluation. Refer to section 3.3 for justification on choosing Likert Scale System.

Several assumptions are made for the Environmental Management System (EMS) evaluation section through Likert Scale System. This is done to make a distinction between management and operations staff in terms of how the factor is affecting both categories and whether the factor is statistically significant or not. Data was verified by applying Pearson Chi-



Square Goodness of Fit Test which is a statistical test applied to categories of data to see if there are differences between the two sets, or in this case the two populations, management and operational staff. Chi Square Goodness of Fit test was chosen due to many factors. First, it provides a 5 x 5 (or less) category analysis that allows us to examine all the 5 variables in the received responses. Second, chi square test allows for analysis of statistical significance of categorical data and provides a robust evaluation of data fit within assumptions and distribution properties (Bearden, et al. 1982). This correlation method was chosen due to its accuracy in capturing all data categories in detail and providing a mechanism for projecting significance and independence for each category under study. Sharpe (2015) has explained that many applied researchers have used chi square test for more than one hundred years where categories must be logical, reliable and defensible, as the case used for this type of survey and data collection work. Categories were defined prior to conducting the survey work where there are two main categories; managers and senior engineers under one category and operations staff and labor under the other category. The significance of factors were tested based on Likert scale categories where it provides a robust method to understand staff positions with regards to each factor.

The statistical assumptions are:

- $\alpha = 0.05$
- Asymptotic Significant values is the Probability-value (P-value) “2-sided”

Cases and conditions for statistical analysis:

- A. If P-value  $< 0.05$  then the factor is “Statistically Significant”, which means respondents’ status is Dependent on (or Not Independent of) this particular factor.
- B. If P-value  $> 0.05$  then the factor is “Statistically Insignificant”, which means Respondents’ status is Independent of (or Not Dependent on) this particular factor.

A table listing statistically significant factors and independent factors will be generated as part of the results analysis for the questionnaire findings. The main chi-square test equation used to interpret the data in a (5 x 2 table) is the following:

$$\chi^2 = \sum_i \sum_j \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

Equation 1. Pearson Chi Square Goodness of Fit Test Equation

Where:

**O** = Observed frequency

**E** = Expected frequency

$\Sigma$  = Summation

**X<sup>2</sup>** = Chi Square value

The statistical package for the social sciences (SPSS) is also used for data analysis. The SPSS package compares data sets easily, saves processing time and allows for complex statistical data analysis (Green & Salkind 2010).

### 3.5 Case Study Objectives

A case study approach is suggested to reinforce the EMS study results and reconfirm the gaps identified through the questionnaire. The results obtained from the EMS questionnaire are considered comprehensive; however, in-depth analysis is required to identify the EMS gaps and their root causes. According to Eisenhardt (1989), case studies help in understanding the dynamics in a single setting and identifying a pattern conforming to various situations. The Environmental Management System (EMS) questionnaire results offer no direct explanations towards the root causes of the issues arising from EMS implementation in the UAE aluminium industry. As such, the results obtained from the EMS questionnaire require a more in-depth analysis to identify the EMS gaps and their root causes. A combined on-site data collection, observation and interviews can present qualitative evidence. Case studies can also be used to provide a description, test theory or generate a theory. For the purpose of this research, the case study will be used to provide a descriptive analysis and verify theories formed during the questionnaire phase. Case study interviews and observations will be used to strengthen the outcomes and confirm the results obtained via the questionnaire.

Therefore, the objectives of this case study are as follows:

1. Validate the questionnaire results
2. Determine root causes of EMS weaknesses in the UAE aluminium industry
3. Investigate the reaction of managers and end-users in regard to environmental performance of the facility
4. Formulate the basis of the framework for enhancing the implementation of the EMS in the aluminium industry

### **3.6 Methodology Summary**

The question that this research tries to answer is how effective is the Environmental Management System (EMS) in managing the environmental and sustainability concerns of the UAE aluminium industry. To answer this question, an evaluation of the EMS current status, successes and weaknesses should be conducted to understand the baseline EMS conditions. This step is similar to the initial review step in the ISO 14001 Environmental Management System. An industry-specific questionnaire is designed with three main sections, demographic questions, EMS evaluation questions and opinion based questions. The questionnaire is distributed to the aluminium industry staff, distinguishing two main categories, managers and operational staff. Around 371 answered questionnaires were collected and analyzed through statistical significance test, Pearson Chi-Square Goodness of Fit Test, to differentiate between dependent (statistically significant) and independent (statistically insignificant) factors affecting the implementation of EMS in the UAE aluminium industry. Following the questionnaire results analysis, a case study is conducted to verify and confirm the results obtained through the questionnaire. The case study comprises from mainly interviews and observations. It helps provide an in-depth analysis of the EMS gaps identified in the UAE aluminium industry. The outcomes from both the questionnaire and the case study will be used together to formulate the basis of the proposed framework for enhancing the implementation of EMS in the UAE aluminium industry.

## Chapter 4: Questionnaire Results Discussion and Analysis

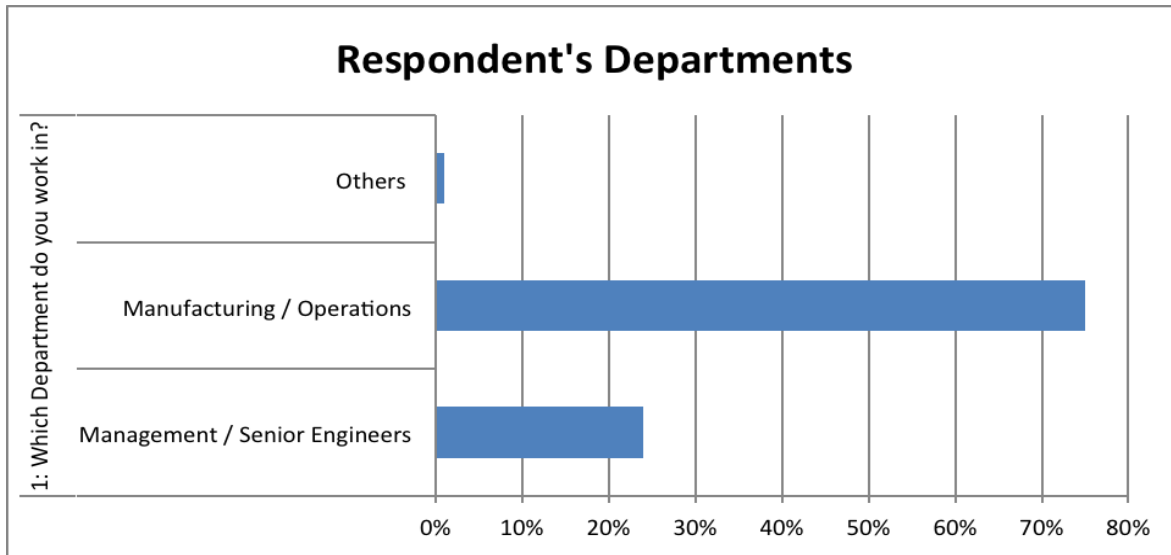
### 4.1 EMS Diagnosis through the Questionnaire

As explained in the methodology chapter, the questionnaire contains three main sections. For more information on the structure of the questionnaire, please refer to Appendix A. The following is a description of the industry-specific survey questions along with the obtained results.

#### 4.1.1 Demographic Questions

- **Respondent Departments**

It can be inferred from Fig. 21 that most of the surveyed population belong to the manufacturing and operations department, with around 75% percent of the respondents. The management and senior engineer's department represents the second largest respondents' level with 24% of responses. Since the focus of the questionnaire is on management / senior engineers and labor staff, which includes operations and manufacturing departments, the "others" section is assumed to be neglected for the purpose of data analysis. This stratification will help reflect the environmental needs in such operational and management level population. According to Tam et al. (2006), most construction professionals should possess a solid manufacturing background that helps them evaluate the environmental performance of the construction materials used in the buildings.



**Figure 21: Respondent's Departments.**

- **Respondent Gender**

Fig. 22 presents a work force comprising of roughly 34% females and 66% males. The gender distribution is not equal due to many factors such as cultural, professional and physical appropriateness. In general, it was hard to find female respondents in the operational fields. More females were found occupying administrative, management, engineering, supervisory and service providing positions rather than positions that require physical activities. Males, on the other hand, were found more in operational positions occupying positions requiring physical labor. A similar unequal gender distribution was found by many researchers in different construction sectors (Dainty et al. 2001). For example, although UAE has its share of modernized females taking on leading industrial roles, there is still some reluctance from many conservative families to allow their women to work in male-dominated industries due to traditional and cultural constraints.

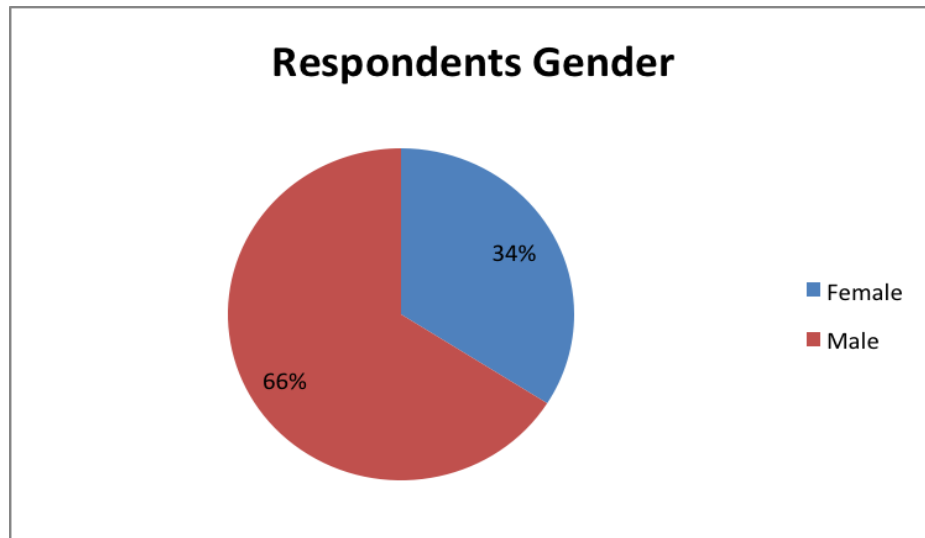


Figure 22: Respondent's Gender.

- **Respondent Age Group**

Fig. 23 shows the respondents' age group indicating that most of the respondents' age falls between 18-44 years. The highest age group is 25-34 years, comprising of 29% of the respondents. This is followed by 27% of the respondents falling within 18-24 years. The 35-44 age group occupies the third place with 24% of the respondents. No respondents fall within 65 or older age group. The age group distribution is natural for employees working at an industrial site. It has been noticed that the higher the age is, the more skilled the labor are, with most of the less skilled operational employees are between 18-24 years old.

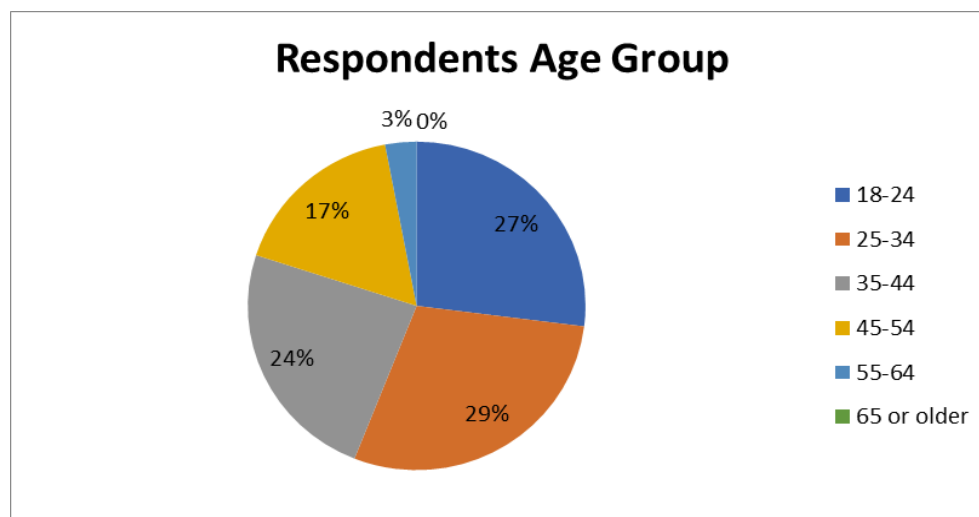


Figure 23: Respondent's age group.

- **Respondent Education Level**

Pertaining to the respondent's educational level, Fig. 24 shows how 42% of the respondents hold a bachelor's degree while 31% of the respondents hold a high school certificate/ diploma. Only 17% of the respondents are Master's degree holders and a mere 6% are PhD holders. Most of the respondents in the latter two groups are positioned in managerial posts. Shi et al. (2013), argue that limited education can be one of the major social barriers against implementing green practices in construction industry. The authors illustrate that most of the operational staff do not have college or university education which is essential in helping them understand the real importance of green construction elements and materials environmental performance. Therefore, the authors suggest that industrial companies must provide their employees with the necessary knowledge to face potential challenges that impact the green construction implementation.

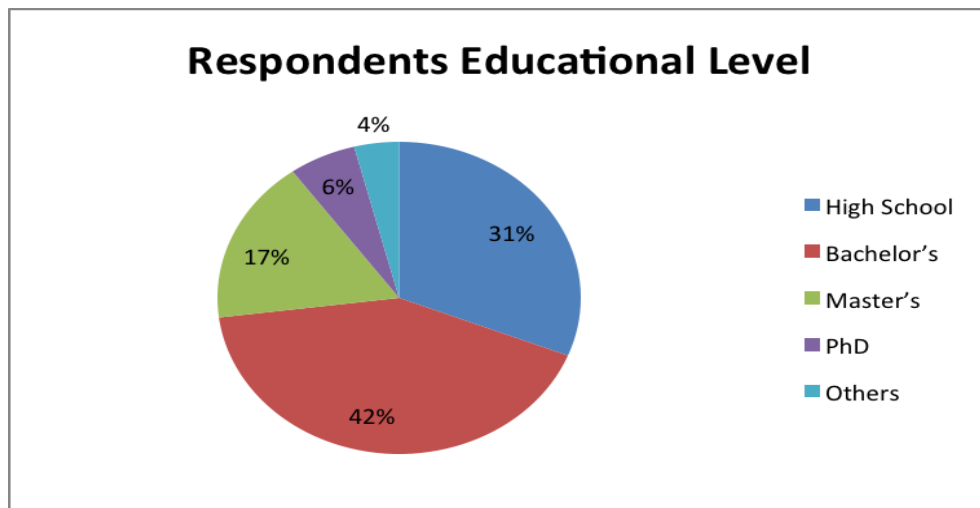


Figure 24: Respondent's educational level.

- **Respondents Experience Level**

Fig. 25 represents the respondent's experience level. According to the survey results, 32% of the respondents are employees with 5-10 years' experience and 31% of the respondents are employees with less than 5 years' experience. Around 29% of the respondents have 11-15 years' experience and only 8% of the respondents have more than 15 years' experience. As such, the experience level was almost evenly distributed among the first three categories while

employees of experience greater than 15 years are the minority. According to Balaban (2012), the lack of experience in construction and industry can lead to negative influences during the environmental and planning phases. Therefore, to ensure the environmental performance of construction and its materials, a highly-experienced employee capable of overseeing the life cycle of construction materials from the operation phase up to the installation phase is essential.

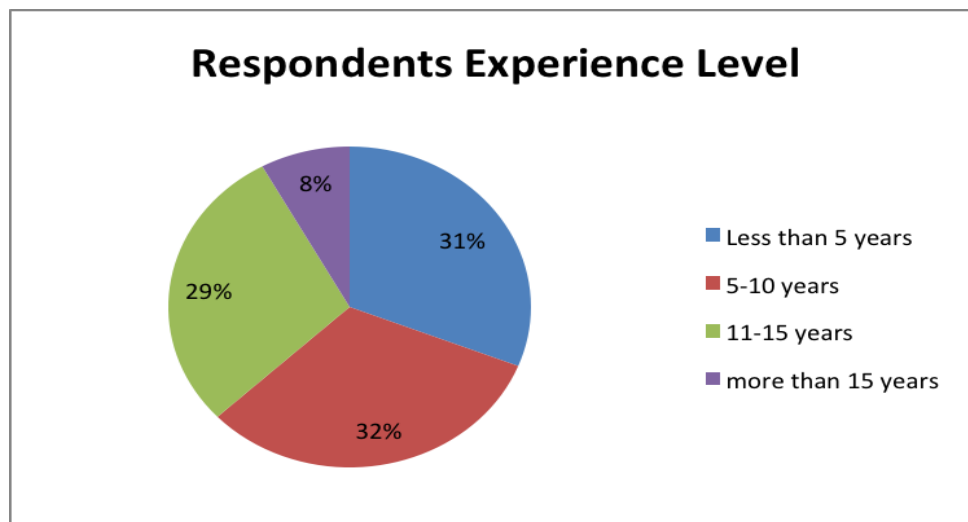


Figure 25: Respondent's experience level.

- **Number of Employees in Respondents Companies**

The two major UAE aluminium manufacturing companies that are the main focus of this survey are EMAL and DUBAL, with a work force of around 3000 employees per each. They merged during the time of this survey to form a mother company of shared investment called EGA, collectively employing 6750 individuals. The respondents of this question were mostly divided between 2 groups as shown in Fig. 26. The first group referencing “1000-3000 employees” representing EMAL or DUBAL alone while the other group referencing “more than 3000 employees” representing EGA. During the merger of the two companies, there was a huge organizational change that led to a communication gap amongst the working level laborers. Many employees rejected the change and operated under the stand-alone company that they originally belonged to. This revealed the lack of communication, reluctance to change culture, and the difficulty of implementing major organizational change in such industry. TSE, R. Y. (2001) explains that one of the major organizational challenges towards the implementation of



Environmental Management System (EMS) in Hong Kong construction is poor communication in the operation stages, something that is echoed in UAE.

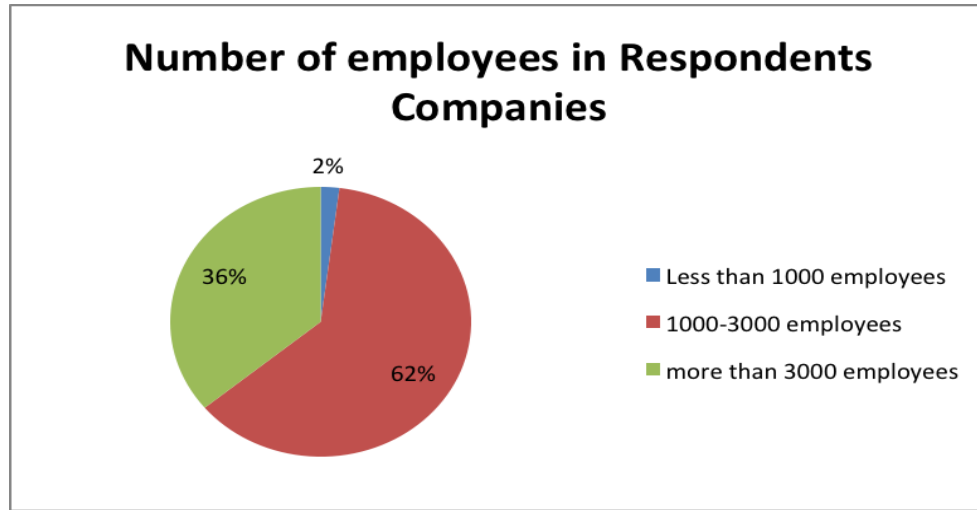


Figure 26: Number of employees in respondents' companies.

There are optional questions included in the demographic section of the survey and are illustrated in Table 6. Some respondents have provided an answer to these questions; however, the majority of respondents have left these questions unanswered.

Table 6. Optional Demographic Questions included in the Questionnaire

Optional Questions	Description	Response
7: Which company do you work for?	Open Statement	A fair number of respondents have abstained from answering this question. Only around 34% of the respondents have answered this question.
8: What is your position in the company?	Open Statement	Some respondents have also declined to answer this question due to the fear of exposing their identity. Only around 31% have answered this question.
9: What is your nationality?	Open Statement	Many respondents have left this question unanswered due to fear of prejudice and stereotyping concerns. Only around 27% have answered this question.

#### 4.1.2 Environmental Management System Evaluation

- **EMS Availability in Facility**

The respondents were asked whether there is an Environmental Management System (EMS) at the facility. The answers obtained varied where 48% of the respondents believe that there is EMS at the facility while 33% of the respondents did not know. Fig.27 provides greater details on the obtained responses. Such a large difference indicates that there is lack of awareness regarding EMS at the facility. According to Zeng et al. (2005), EMS training directly reflects the employees' awareness about environmental management issues at the facility. Training not only develops and enhances the technical skills, but it illustrates the conceptual background about the benefits of implementing EMS in the operation process.

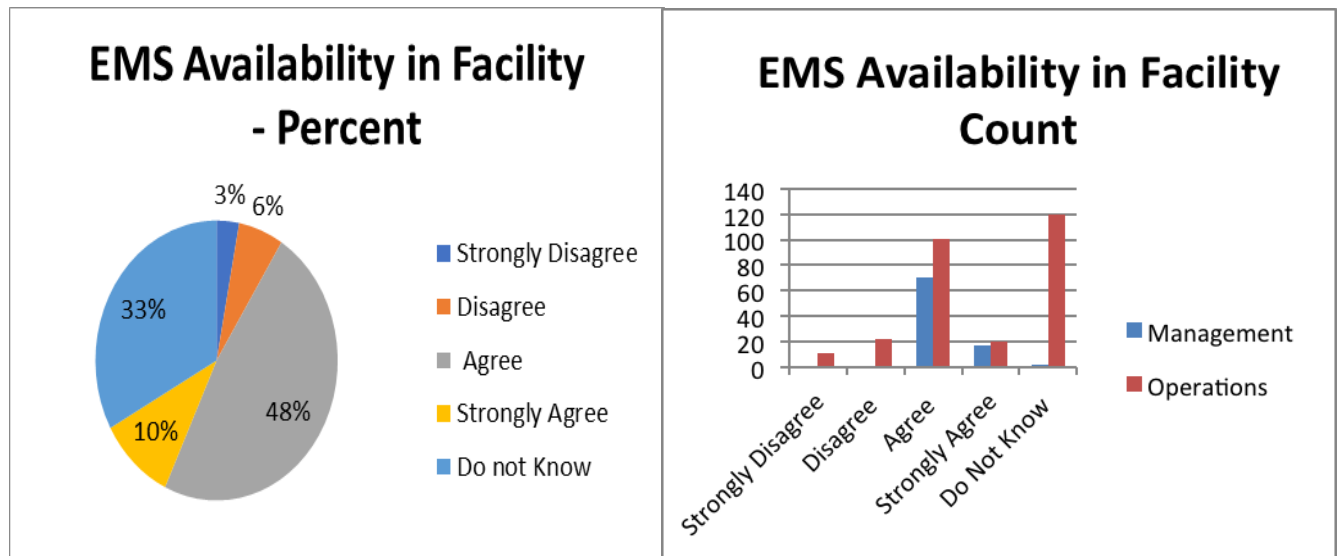


Figure 27: EMS Availability in facility.

For the data analysis and by applying all previous assumptions, all management respondents have agreed that there is an Environmental Management System (EMS) in their facility, while operational staff response varied between agree and do not know. This can be attributed to the EMS training and awareness deficiency at the facility. By applying chi square test to the set of responses for management and operational staff, the chi square statistic is 76.0513 and p-value is 0.00001. Thus, the result is significant at  $p < 0.05$  which further

emphasize the EMS training deficiency and knowledge gap between management and operational staff.

- **Existence of Environment Department at the Facility**

The respondents were asked whether there is an environmental department at their facility. Many employees are not even aware of the existence of an environmental department at the facility according to Fig.28. This is due to the fact that, by and large, the environment department is included within the EHS umbrella. When compared to the indirect losses arising from environmental issues, health and safety issues are well promoted because failure in matters related to health and safety cause direct losses. In addition, many staff work in silos and are oblivious of the organizational structure or the department's functions. Christini et al. (2004) suggest including the organizational structure of the facility and introduction to the environmental department function in the induction of new hire to increase the level of staff awareness. Around 41% of respondents agree on the existence of an environmental department which is still a great indicator of department awareness.

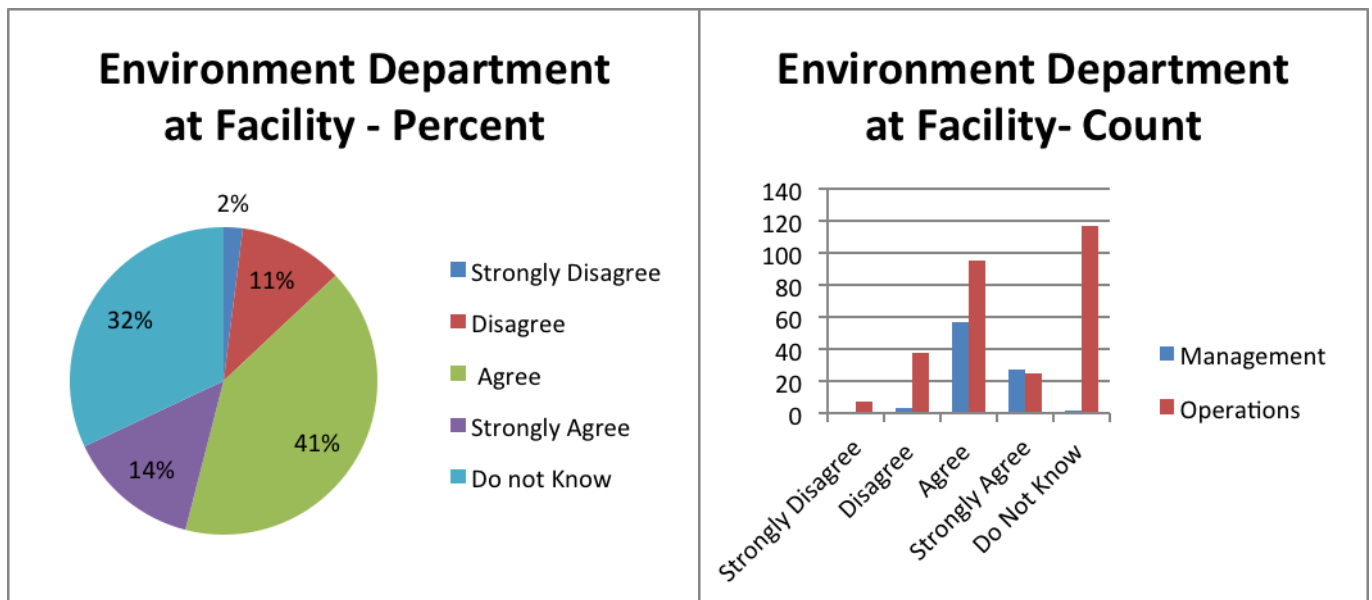


Figure 28: Existence of environment department at the facility.

To analyze the responses in terms of statistical significance, most management and senior engineers have agreed to the presence of an Environmental Department at the facility while again the operational staff responses varied between “agree” and “do not know”. This reflects the weakness in knowledge about department functions and lack of communication. By applying the chi square test to the set of responses from management and operational staff, we notice that the chi square statistic is 78.4. The p-value is  $< 0.00001$  which is less than 0.05 meaning that the result is significant and there is difference between management and operational staff with regards to knowledge about the existence of an environmental department.

- **Facility’s Environmental Policy**

The environment policy plays a vital role in communicating the company's environment vision. It should be clearly communicated in a language understood by the staff and written for all workers at the facility. The respondents were asked whether the environmental policy is visible, accessible and well communicated. As displayed in Fig. 29, a fair percentage of (35% + 15% = 50%) of staff members believe that the environmental policy is not visible, accessible or communicated. This percentage indicates a huge gap in the Environmental Management System (EMS), environmental policy communication and implementation. According to Shen et al. (2010), a clear environment policy is the key to an improved EMS implementation. Through the organization networking, the environment policy provides the main legal background for all the required communication in order to implement the EMS in the operation processes. In addition, the authors believe that the environment policy in the operation stage helps the construction organization to have a legal cover in the case of environmental accidents occurring at the operation or construction stages.

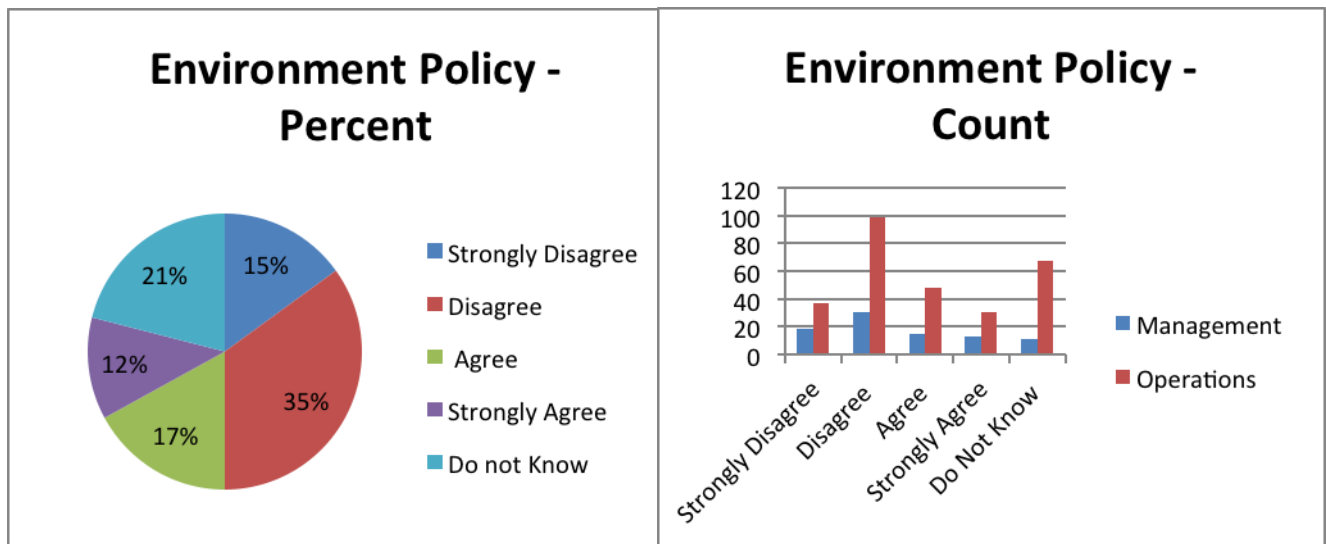


Figure 29: The environmental policy is visible, accessible to all staff and well communicated.

With regards to the statistical analysis for the significance of Environment Policy questions, both management and operations staff have indicated a gap in the communication of effective environment policy at the facility where their results were mostly shown around “disagree” and “Do Not Know”. By applying the chi square test to the set of responses from management and operations staff, we note that the chi-square statistic is 7.9627. The p-value is .092954 which means that result is not significant at  $p < .05$ . This indicates that there is no difference between management and operations staff when it comes to agreeing that the environment policy is not visible, accessible or well communicated at the facility.

- **ISO 14001 Certification at the Facility**

According to Fig. 30, 42% of the staff is often unaware if their company is ISO14001 certified. The reality is that some operational processes are ISO certified using different quality and engineering standards. However, at the time of this survey, only the Jebel Ali site had the ISO14001 certification while the Taweela site did not. This was because the Jebel Ali site was established far earlier than the recently established Taweela site. In fact, the Jebel Ali aluminium smelting site began operating in 1979 while the Taweela site began operating in 2009 (Dubai Aluminium Company Limited, DUBAL 2014). 30% of the staff who agree that the company is ISO 14001 certified belong to Jebel Ali site. According to Liyin et al. (2006), it will be very challenging to implement the Environmental Management System (EMS) in the technical

process if employees are unaware of the conceptual role and purpose of the ISO 14001 because it enhances both the behavioral and the technical skills of the employee. This is especially true for the end users.

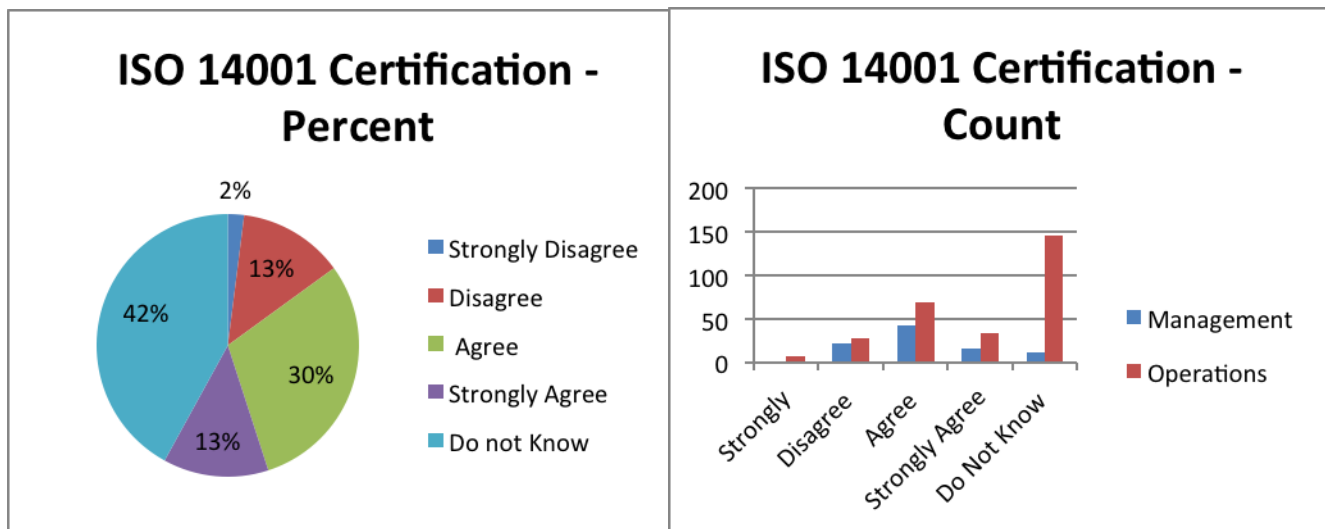


Figure 30: The Company is ISO 14001 Environmental Management System certified.

The statistical analysis with regards to ISO 14001 certification question revealed a statistical significant difference between the set of responses provided by management and operational staff. The chi-square statistic is 50.3838. The p-value is  $< 0.00001$  which means that the result is significant at  $p < .05$ . Fig.30 further stresses this conclusion by indicating the large number of operational employees who do not know whether their company is ISO 14001 certified or not. The difference between management and operational staff shows a communication gap on the stature of the ISO 14001 certification in the company. Most staff from Jebel Ali site have agreed to the presence of the ISO 14001 certification at their facility while staff from Taweela site have varied response between “Do Not Know” and “Agree”. In fact, Taweela site as explained above do not hold an ISO 14001 certification for the entire plant and only specific manufacturing process are ISO certified under different ISO engineering standards, not directly related to the Environment Management System certification.

- **Facility’s Local EHSMS Registration**

Regulations enforcement plays a dynamic role in implementing the Environmental Management System (EMS) in the workplace that are coming from the legislation bodies in the

country. Psomas et al. (2011) explain that legislation and monitoring governmental bodies can ensure the effectiveness of the EMS through frequent audits and inspections that will result in exposing the gaps in the system. Generally, in UAE there is lack of specific EHS bodies that oversee the implementation of EMS in the operation facilities at different industries. However, in Abu Dhabi Emirate, a local EHS authority was established in 2010, Abu Dhabi Occupational Safety and Health Center (OSHAD). OSHAD has the responsibility of evaluating the existing EHS systems in different industrial sectors. Since OSHAD is a fledgling authority, it can only examine the EHS systems at industrial companies that are registered with them. Fig. 31 shows that most of the employees (53%) do not know if their organizations are registered with local EHS authority, which indicates a lack of knowledge regarding the EHS legislation enforcement among the employees.

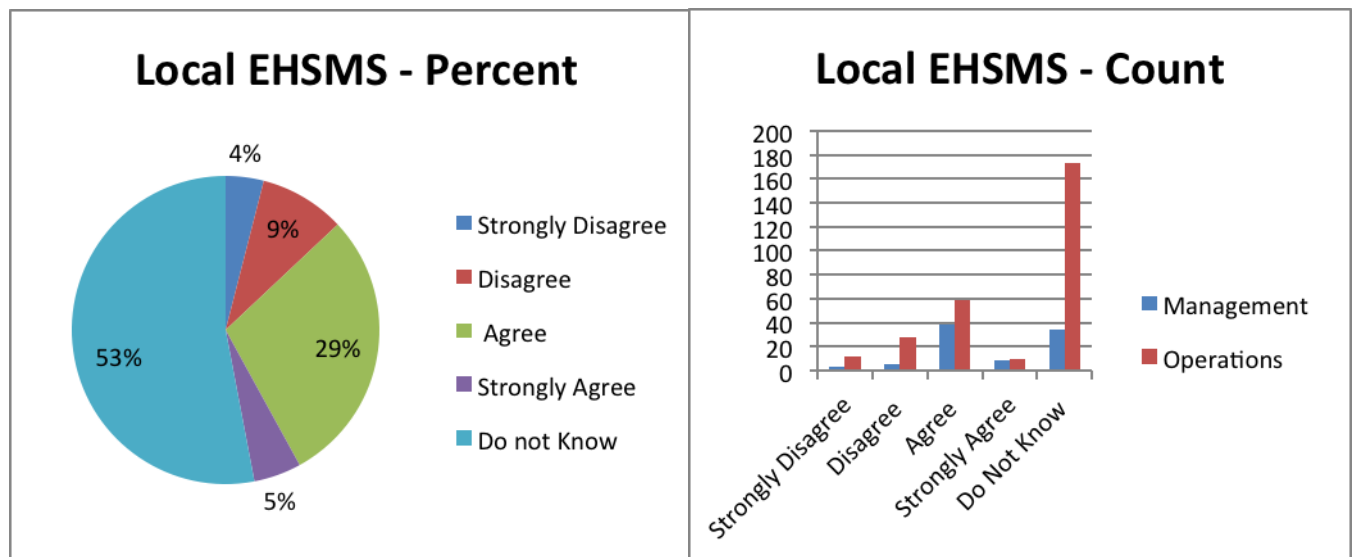


Figure 31: Registration in the local Environment Health and Safety Management System.

Calculation of the statistical significance of the set of responses from management and operational staff showed that there is significant difference through chi square test. The chi-square statistic is 26.0029. The p-value is .000032 which means that result is significant at  $p < .05$ . Most of the management and operational staff have responded on this question with “Agree” and “Do Not Know”. Furthermore, Fig. 31 illustrates a large number of operational respondents who do not know whether their company is registered in the local EHSMS. This clearly stresses on the significant difference in knowledge about local EHSMS between management and operational staff. There is also lack of knowledge sharing and capacity building for

operational staff to enable them to understand environmental legislative requirements applied at their workplace.

- **Internal Environmental Audits at the Facility**

Hillary (2004) mentions that operation facility can ensure the environmental integrity through procedural practices such as management review and external/internal audit. The author believes that internal audit system has an advantage in evaluating the environmental performance owing to its direct access availability to all required documents. In addition, the corrective actions of internal audit typically take less time to be applied. In fact, most operation plants are conducting internal audits on a quarterly basis. The purpose of the internal environmental audit is to fulfill the environmental performance of the operation process with respect to the business plan of the organization. Fig. 32 shows that the majority of employee (29% Disagree, 16% disagree) are unaware if they carry out internal audits to measure the environmental performance at their operation facilities. Surprisingly, most of the respondents hold operational positions. This strongly refers to the technical needs for internal environmental assessment that can enhance the Environmental Management System (EMS) implementation.

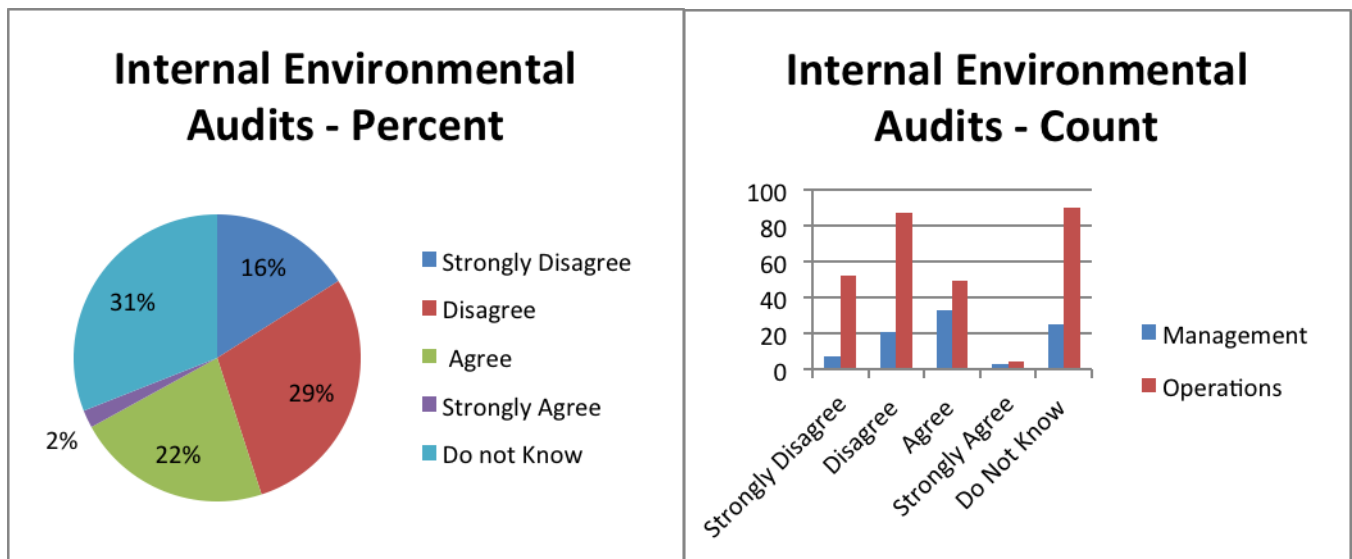


Figure 32: Internal environmental audits conducted by facility staff.

By analyzing the statistical significance behind this question, the responses show a statistical significant difference between the set of responses provided by management and operational staff. The chi-square statistic is 19.5478. The p-value is .000613 which means that



the result is significant at  $p < .05$ . The lack of environmental awareness among operational staff has been observed as a common element in most of the basic environmental knowledge questions. Fig. 32 states that when it comes to internal environmental audits, operational staff responses were concentrated around “Disagree” and “Do Not Know”, in addition to a fair amount of response that have agreed to the question. The same applies to the management staff responses but mostly their responses were concentrated around “agree”. In fact, there is no specific pattern that can be observed with relevance to operational and management staff responses but there is statistical difference among them.

- **External Environmental Audits at the Facility**

Investments and loans for the company expansion projects typically receive financial support from external bodies such as World Bank. Thus, the contractual agreements between the company and the lender body mandate that a certain level of environmental performance at the facility is maintained. The lender body sends their representatives for environmental audits and inspections at the facility to ensure that their investment is secured. In addition, the regulator inspects all industrial facilities on a rotational annual basis, perhaps two or three times a year based on man-power and inspection team availability. Furthermore, the company itself may hire an external third party such as consultants to audit their facility and test their compliance level. All of these external audits play an important role in enhancing the environmental management system performance which reveals the flaws in the Environmental Management System (EMS) using fresh, unbiased external eyes (Zutshi & Sohal 2003). Fig. 33 depicts how around 39% of staff are unsure whether there are external audits conducted at the facility or not. This percentage reflects the lack of awareness and communication to some levels of staff such as operational labor. Similarly, a great percentage of staff responded that the facility undergoes external audits by third party (34% agree and 5% strongly agree). An explanation for this is that such respondents are frequently involved in the external audit process, particularly management and senior level operational staff.

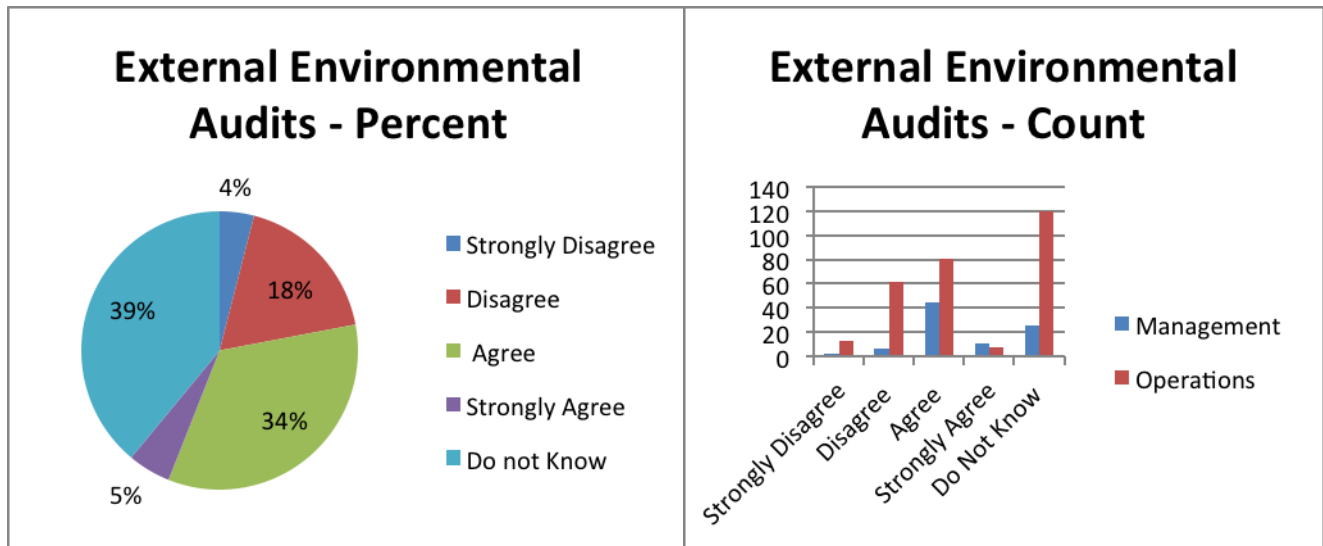


Figure 33: Annual external environmental audits conducted by third party.

There is a significance difference of knowledge about external audits conducted at the facility between the set of responses obtained from management and operations staff. The chi-square statistic is 35.9627. The p-value is  $< 0.00001$  which means that the result is significant at  $p < .05$ . As Fig. 33 explains, the majority of the operations staff does not know about the existence of external audits by third party at their facility while the remaining operations staff responses varied between “agree” and “disagree”. Most management staff have indicated that they know about the external third-party audits at their facility.

- **Environmental Training at the Facility**

Training is an important pillar of the Environmental Management System (EMS). It is the main means of communicating the EMS aims, objectives and execution needs. According the Daily and Huang (2001), environmental training at the facility is mainly used to educate staff about the main environmental aspects, impacts and mitigation measures relevant to their industry. The respondents were asked whether the facility conducts regular annual environmental training for the staff. Fig. 34 shows that a great percentage of the respondents (48% agree, 11% strongly agree) agree that the facility conducts regular annual environmental training for their staff. This is an excellent percentage; however, if compared to the obvious lack of awareness and communication gleaned from previous responses, it in fact unravels more deficiencies.



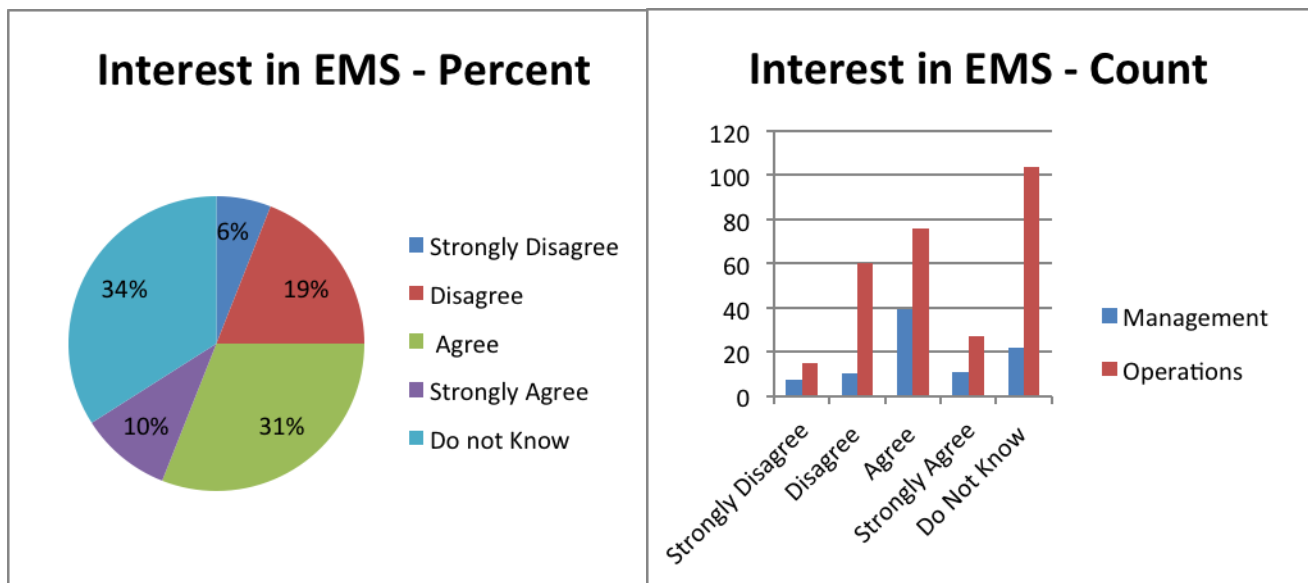
Figure 34: The facility conducts regular annual environmental training for the staff.

This question did not explore the quality and quantity of environmental training provided at the facility. Refresher environmental training for current staff, induction for new joining employees and specific environmental training for contractors involved at the workplace share an equal level of importance when it comes to delivering high level industrial Environmental Management System (EMS) training. 21% of the respondents answered that they don't know whether annual environmental training is provided and 19% respondents disagree with the statement that there is regular annual environmental training conducted at the facility. It is evident that if an in-depth environmental training is provided to all staff then the environmental awareness at the facility would also rise, positively influencing all other operational functions.

By applying chi square test to the set of responses obtained from management and operations staff on this question, a significant difference is noticed. The chi-square statistic is 28.8263. The p-value is  $< 0.00001$  which means that the result is significant at  $p < .05$ . This again stresses out that management and operations staff gap is large and these two populations and their views are not the same. Fig. 34 shows that most management and operational staff agree that there is regular environmental training conducted at their facility, while a fair number of operations staff either "do not know" or "disagree" about this statement.

- **Facility's Interest in EMS**

Signs of interest in the Environmental Management System (EMS) can be detected through leadership involvement and commitment towards environmental related issues at the facility. The respondents were asked whether there is interest in EMS at their facility. Around 31% agree and 10% strongly agree that there is interest in EMS at the facility. On the flip side, 34% of the respondents have indicated that they don't know whether there is interest in EMS or not as shown in Fig. 35.



**Figure 35: There is interest in EMS at your facility.**

Statistical analysis of this question reveals that there is a significant difference between management and operations staff when it comes to interest in the Environmental Management System (EMS). A large number of operations staff do not know whether there is interest in EMS or not while the remaining number of operational staff responses varied between “agree” and “disagree”. Most management staff have agreed that there is interest in EMS at their facility. The chi-square statistic is 14.023. The p-value is .007222 which means that the result is significant at  $p < .05$ . There is clearly a difference between management and operations staff responses that can only enlarge the knowledge gap between the two groups.

With reference to Fig. 16 that explains the categories of ISO 14001 standards, process and organization standards and product oriented standards are the main categories for ISO 14001

standards (Cascio 1996). This question confirms that interest in EMS is mainly related to certification as it has positive impact on the company's image whereas interest should preferably be in life cycle assessment and environmental labeling for the product. Since management see no direct profit in the second category, limited improvement is seen in product life cycle assessment and circular economy implementation.

- **Funding Impact on EMS**

Funding is a major factor that affects the implementation of the Environmental Management System (EMS). Some facilities accrue greater costs when adopting an environmental management system (EMS). Darnall and Edwards (2006) have investigated the impact of funding on EMS implementation and concluded that publicly owned facilities had lower EMS adoption costs because of stronger complementary capabilities prior to EMS adoption. Conversely, government facilities and privately-owned enterprises had fewer capabilities and accrued higher EMS adoption costs. Public owned facilities are owned by individuals and have sold portion of the company through stocks that are publicly traded. On the other hand, government facilities are completely owned by the government and privately-owned enterprises are completely owned by their founders or group of private investors. Organizational capabilities and availability of resources affect EMS success and implementation directly due to funding associated with EMS related functions.

The respondents were asked whether lack of funding is a major factor affecting the implementation of EMS. Fig. 36 indicates that around 35% agree and 18% strongly agree with the statement that lack of funding is a factor that affects the implementation of EMS whereas 37% have stated that they are not sure and do not know. It is also noticeable in times of financial crisis, some of the first functions that seem to be affected are service related functions such as environment and HSE. Functions such as these accumulate loss in manpower and budget constraints since they lack a strict regulatory compliance mandating the availability of environment experts among the staff. For example, Crotty (2009) explains that upon facing financial crisis, most construction organizations minimize or cut the funding and manpower for non-production divisions such as environment and safety.

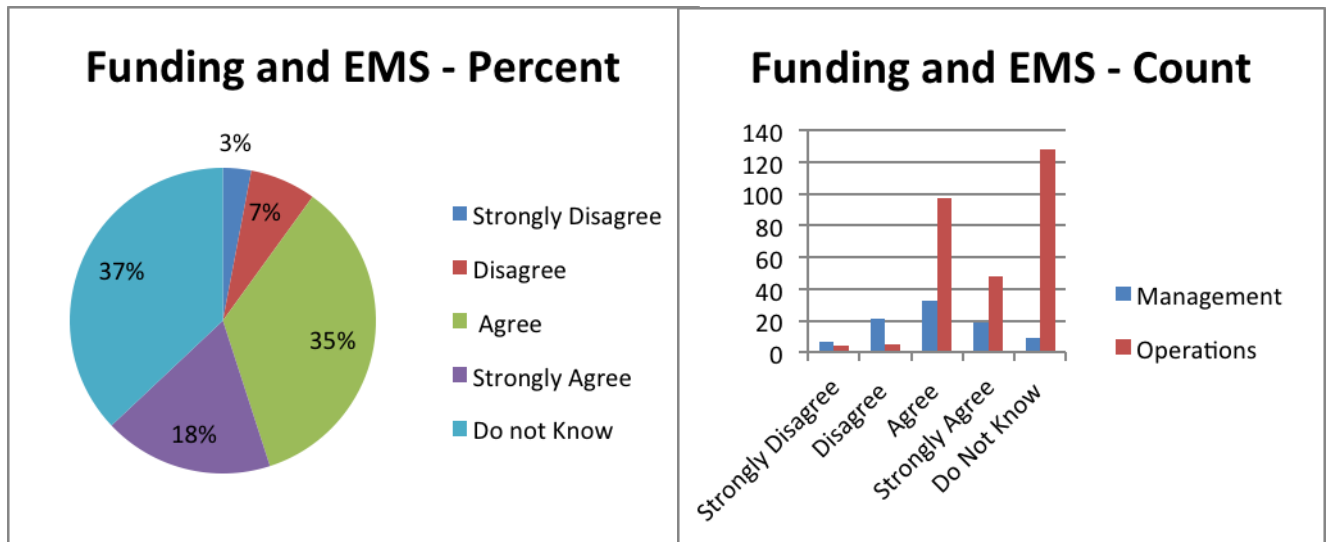


Figure 36: Lack of funding is a factor that affects the implementation of EMS.

The statistical analysis for significance shows that there is a significant difference between management and operations staff in believing that funding is a factor that affects the implementation of the Environmental Management System (EMS). The chi-square statistic is 79.0918. The p-value is  $< 0.00001$  which means that the result is significant at  $p < .05$ . Most operations staff do not know or agree that funding is a factor that affect the implementation of EMS, while management staff responses varied between agree and disagree with this statement.

- **Facility's Organizational Support Towards EMS**

Daily and Huang (2001) believe that human resource factors such as top management support, environmental training, employee empowerment, teamwork, and rewards systems are key elements of the implementation process of an Environmental Management System (EMS). Organizational support serves as a one of those top elements for a successful EMS implementation. Fig. 37 represents respondents' opinion regarding the statement that there is strong organizational support towards EMS at the facility. Around 36% disagree and 12% strongly disagree that there is strong organizational support at the facility. As such, 48% indicates the weakness of the organizational support system including top management support and employee empowerment. Around 30% of staff indicates that they don't know whether there is a strong organizational support at the facility or not. This percentage is attributed, again, to the lack of awareness and involvement of staff. Fig.37 further illustrate the responses obtained from

management and operational staff, where most operational staff either “do not know” or “disagree” with the statement of strong organizational support towards EMS. The majority of management staff agree on the existence of strong organizational support towards EMS, while a fair amount of operational staff do not know or disagree with this statement. By applying the chi square test, the chi-square statistic is 44.8177. The p-value is  $< 0.00001$  which means that the result is significant at  $p < .05$ . This indicates a significant difference between management and operational staff with regards to EMS organizational support.

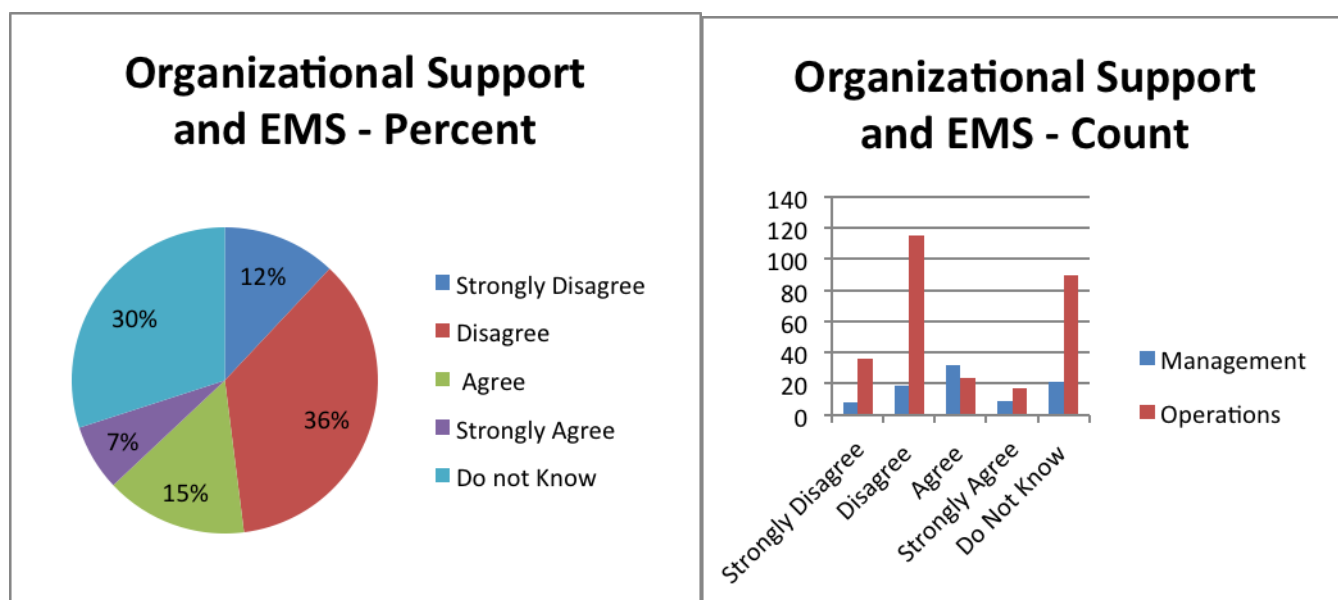


Figure 37: There is strong organizational support towards EMS in your facility.

- **Quality of Environmental Data at the Facility**

Environment related data collected from operational staff should be of good quality to represent sound environment reporting system. Lack of knowledge and awareness about these environmental data and how to collect them and what is their importance are factors affecting the quality of reported data from departments. Therefore, environment training plays an important role here in educating staff prior to reporting and collecting data. Such data include air pollutants concentrations collected through Continuous Emissions Monitoring Systems (CEMS), concentration of contaminants in plants and soil, and amount of waste generated from operational processes. Fig. 38 shows that 43% disagree and 11% strongly disagree with the statement that the environmental related data collected from departments are of good quality

while 32% do not know. The combined percentage of 54% disagreeing is ringing an alarm bell and indicating that there is a problem in environmental reporting and awareness. Montabon et al. (2006) suggest that having active reporting atmosphere can enhance all the environment management practices inside the organization. Fig.38 shows the responses count obtained from management and operational staff with regards to quality of environmental data. Most operational staff do not know and disagree about the statement that environmental data collected at the facility are of good quality, likewise most management staff disagree about the same statement. By applying the chi square test, we still notice a significant difference between the set of responses provided by management and operational staff. The chi-square statistic is 9.9445. The p-value is .041373 which means that the result is significant at  $p < .05$

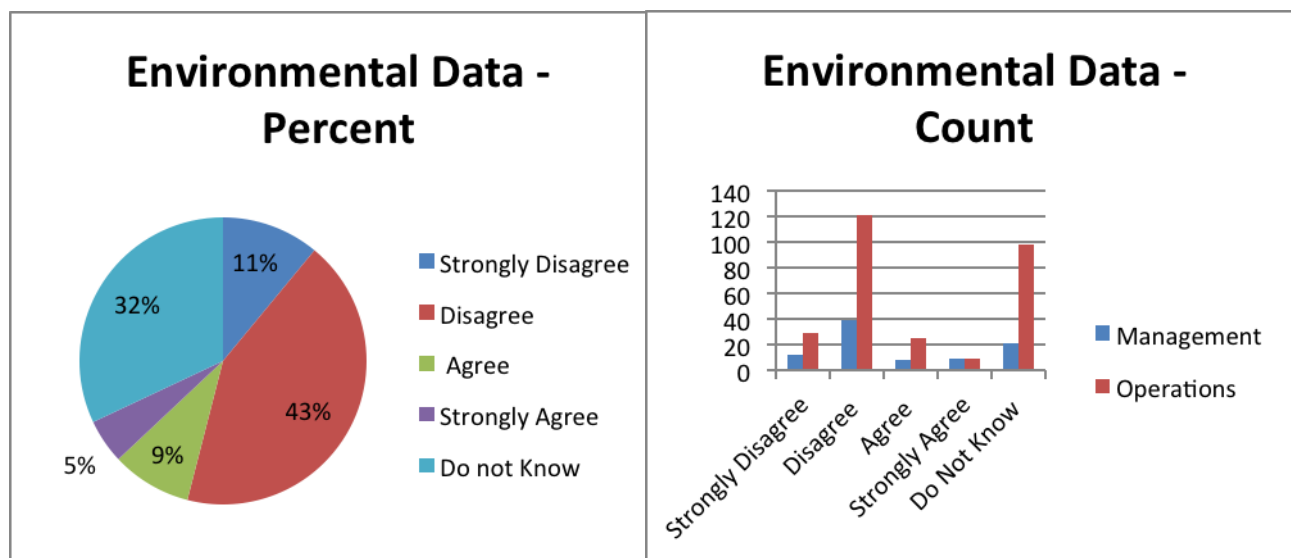


Figure 38: The environment related data collected from departments are of good quality.

A formal Environmental Management System (EMS) process should include proper reporting and since only Jebel Ali site has the advantage of a formal EMS process while Taweela site does not have it yet, the results vary significantly. Melnyk et al. (2003) have studied the impact of EMS on corporate and environmental performance and conducted a survey. They concluded that firms that have a formal EMS established beyond pollution abatement have better environmental operational performance. The authors believe that firms having gone through EMS certification experience a greater impact on performance when compared to firms with uncertified EMS.



- **Leadership Transparency in EMS Implementation at the Facility**

Alaati et al. (2016) expounds that nowadays leaders must be able to handle complexity and changes within organizations as well as maintaining performance at a high standard. This illustrates the strong relationship between leadership behavior and environmental performance. In fact, the status of the Environmental Management System (EMS) implementation is mainly dependent on leadership behavior. Top management commitment towards EMS implementation can be seen not only through written statements but also activities, communication messages, and employee involvement. This ensures that these companies' sustainability and environmental reports are not just visually appealing reports (Morsing & Oswald 2009). The case study of Robinson and Clegg (1998) reveals that environmental leadership can provide competitive advantage for the product through EMS standard using process cost savings in terms of energy and materials and reduction of waste in addition to catering the demand of market for environmentally friendly products. This certainly proves that leadership plays a significant role in tailoring the implementation of EMS. Fig. 39 indicates that around (48% disagree + 28% strongly disagree) 76% of the respondents disagree with the statement that leadership is transparent in implementing the EMS. This massive percentage reveals a definite shortcoming in the leadership's style and approach towards EMS implementation.

The statistical analysis of significance between the two set of responses obtained from management and operational staff vary greatly as explained in Fig. 39. Most operational staff disagree that leadership is transparent in implementation of the Environmental Management System (EMS) while management responses are distributed in random pattern. Many management respondents have escaped answering this question by choosing "do not know" option while other indicated their "agree" or "disagree" on the statement. By applying chi square test, it is clear that the chi-square statistic is 163.0632. The p-value is  $< 0.00001$  which means that the result is significant at  $p < .05$  further emphasizing that the management and operational staff responses are different.

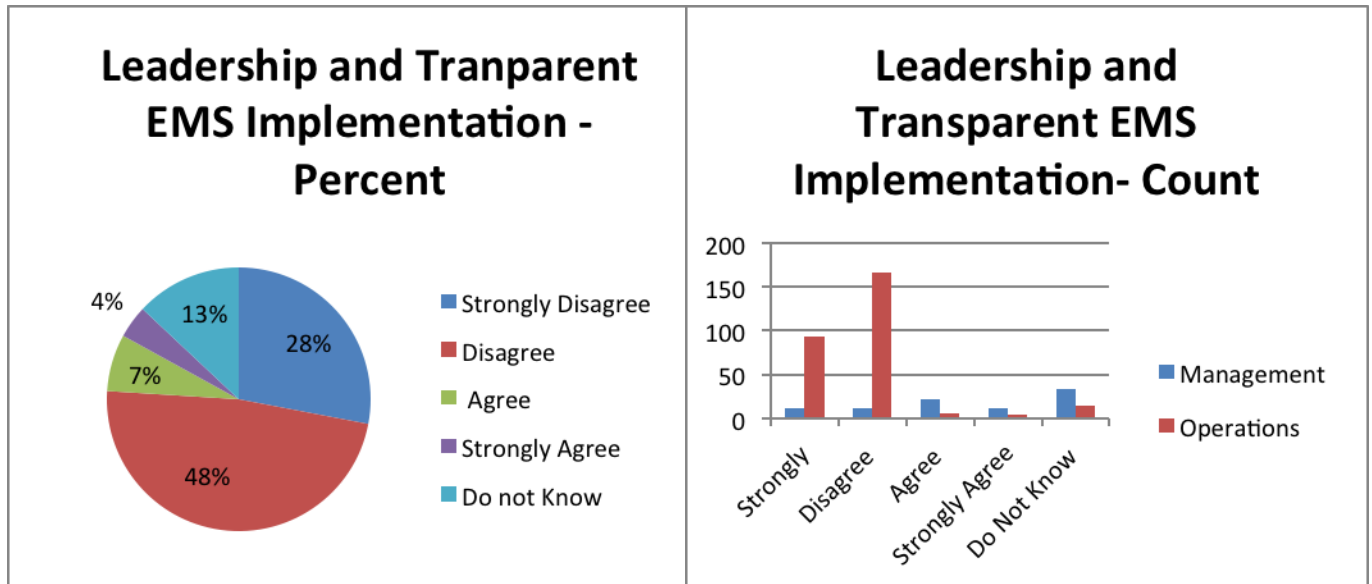


Figure 39: Leadership management is committed to transparency in EMS implementation.

Annandale et al. (2004) explain how the Environmental Management System (EMS) implementation cannot be applied without a visible leadership from the senior management. It is crucial that the leadership maintain a transparent EMS implementation process for reporting, awareness and respect for their employees. The authors hold that visible leadership makes the individual employees keener to understand direct environmental and health hazards related to their daily tasks and operations. Kolk and Mauser (2002) support this idea, believing that the environmental management performance can be enhanced for a group of workers by targeting senior individual labors that hold experience as they can sense the management environmental leadership and commitment.

- **Accountability in Fulfilling Objectives at the Facility**

Accountability is another trait of sound leadership. Accountability for the set environmental targets and objectives in the Environmental Management System (EMS) is a sure measure of improved environmental performance through continuous improvement (Zadek et al. 2013). The respondents were asked whether there is lack of accountability in fulfilling the set targets and objectives. Fig. 40 shows that the majority of respondents believe that there is a lack of accountability in fulfilling environmental targets and objectives. Around 57% (34% agree + 23% strongly agree) of the respondents agree that there is lack of accountability in fulfilling targets and objectives, while 27% remained neutral about this statement. The authors suggest that

the accountability and responsibility towards EMS targets are mainly associated with budget constraints, availability of skilled manpower, regulatory and compliance pressures along with other external factors. Another important role of accountability in EMS is that it defines the scope of the work for all employees thus helping implement EMS more effectively inside the organization (Sarkis et al. 2010).

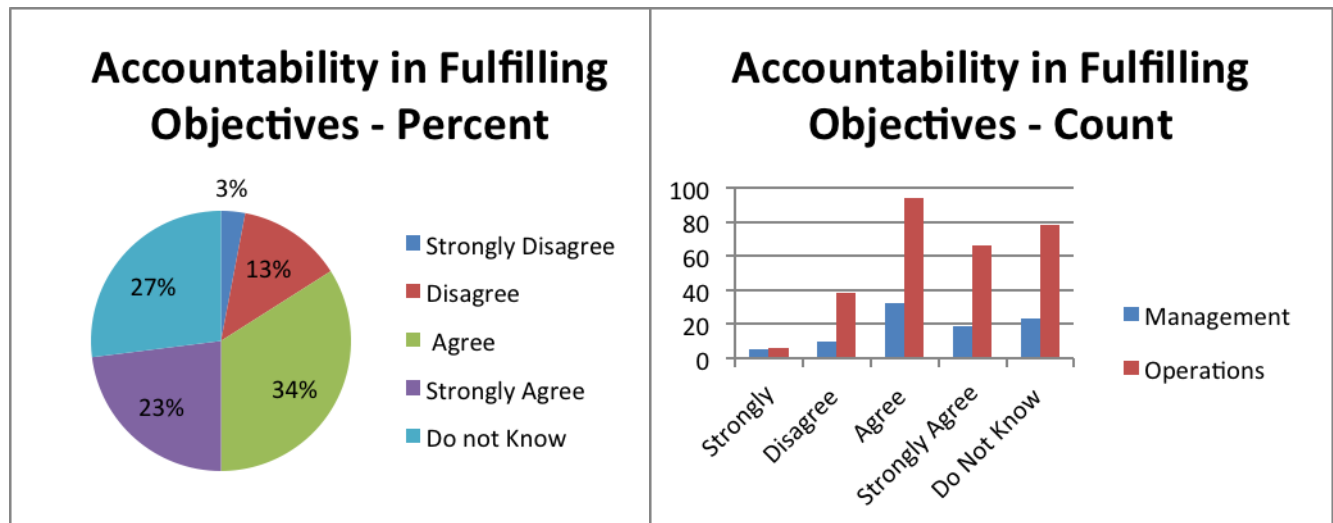


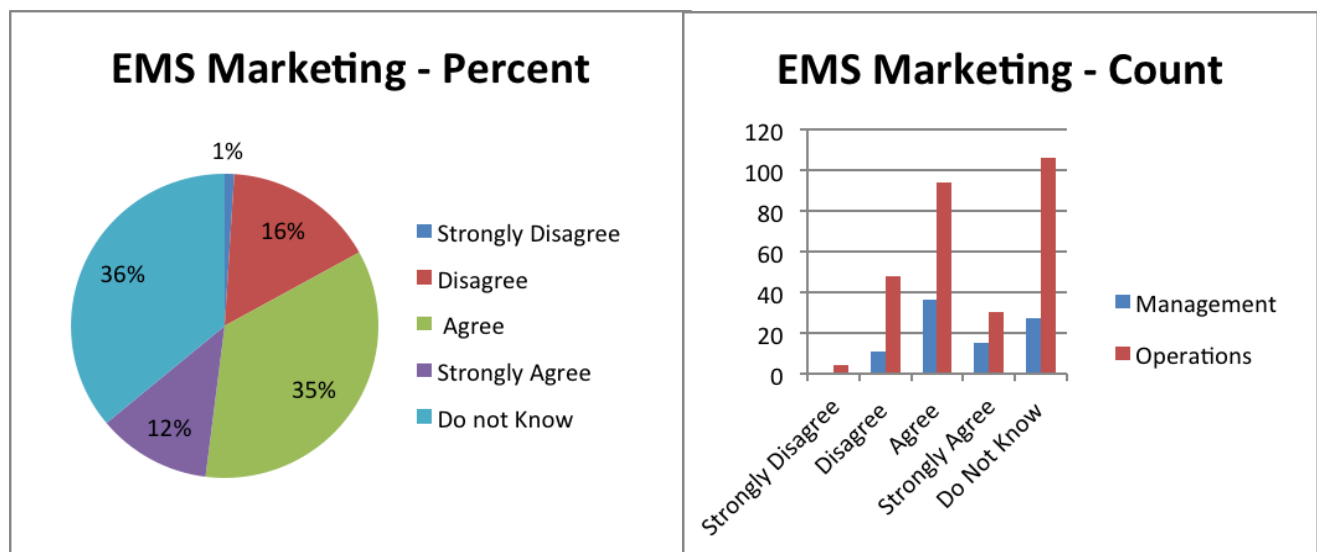
Figure 40: Lack of accountability in fulfilling the set objectives and targets.

Fig. 40 further illustrates the management and operations staff responses regarding the lack of accountability in fulfilling the set objectives and targets. Generally, most management and operations staff agree with the latter statement. In fact, by applying the chi square test, the chi-square statistic is 3.3855. The p-value is .495502 which means that result is not significant at  $p < .05$ . This result indicates that there is no difference between the opinions of management and operational staff when it comes to the lack of accountability in fulfilling the set objectives and targets and that they almost all agree on this aspect.

- **EMS Benefits in Facility Marketing**

To further Robinson and Clegg (1998) work on competitive advantage, adoption of the Environmental Management System (EMS) can enhance the product's marketing and branding by increasing the number of clients and expanding the business. Nowadays, consumers are more aware of the impact their purchased products have on the environment and stand to make

informed decisions by buying environmental friendly products. Adoption of EMS can certainly enhance the company's environmental image and open further business opportunity (Biondi et al. 2000). The respondents were asked whether their facility benefits from marketing and branding in adopting the EMS by increasing number of clients and expanding business. Fig. 41 shows that 47% of the respondents believe that the company's marketing and branding benefits from the adoption of EMS. 36% remained neutral thus indicating that they do not know. However, there is no direct evidence for this pertaining to local aluminium industry in UAE as the market is solely exclusive on the main two aluminium smelters, DUBAL and EMAL. That said, internationally, green and environmental products are certainly more desirable and add more value than non-environmentally friendly materials. For example, according to Zhu et al. (2005) environmental footprint of Chinese products is inordinate making them less desirable in the international market thereby affecting the reputation of most Chinese industrial companies. As such, it is vital for the Chinese industries to adopt EMS to negate their negative image.



**Figure 41: Benefits in Marketing and Branding by adopting EMS.**

To analyze the results in terms of statistical significance, the response obtained from management and operations staff exhibit similar patterns. Most management and operations staff indicates that their company benefit from the Environmental Management System (EMS) marketing. By applying chi square test to the set of responses obtained from management and operations staff, the chi-square statistic is 6.3116. The p-value is .177057 which means that the

result is not significant at  $p < .05$ . This result shows that there is no difference between management and operations staff when it comes to agreeing that their company benefit from marketing and branding by adopting the EMS.

- **Facility Environmental Improvements after EMS Implementation**

The respondents were asked whether there is real drive of environmental improvements and reduced environment risks after implementing the EMS. Fig. 42 indicates that around 41% of the respondents do not know whether there is a real drive for environmental improvements and reduced environmental risks after implementing the Environmental Management System (EMS). An operational employee would not be able to assess the level or reduced risks and environmental improvements related to EMS performance. This responsibility lies on the shoulders of those environmental specialized personnel working at the environment department as they are the subject matter experts. In addition, collectively 41% of the respondents (32% disagree and 9% strongly disagree) disagree that there are environmental improvements and reduced risks after implementing the EMS. Such two extremes exemplify how the facility is perhaps not harvesting the benefits of existence of the EMS considering how EMS' main function is to reduce the environmental impacts relevant to the main activities and ensure continuous improvement. The EMS is far from just an image enhancer and extends to real-time improvements of business and processes related to the facility operations (Testa et al. 2005).

The statistical significance of this question and comparison between the set of responses obtained from management and operations staff reveals that the two latter groups are different in relevance to believing that there are real environmental improvements after the implementation of the Environmental Management System (EMS). The chi-square statistic is 92.7519. The p-value is  $< 0.00001$  which means that the result is significant at  $p < .05$ . Most operations staff disagree or are not sure whether there are real environmental improvements at the facility after implementing the EMS while most management staff agree that environmental improvements exist after EMS implementation.

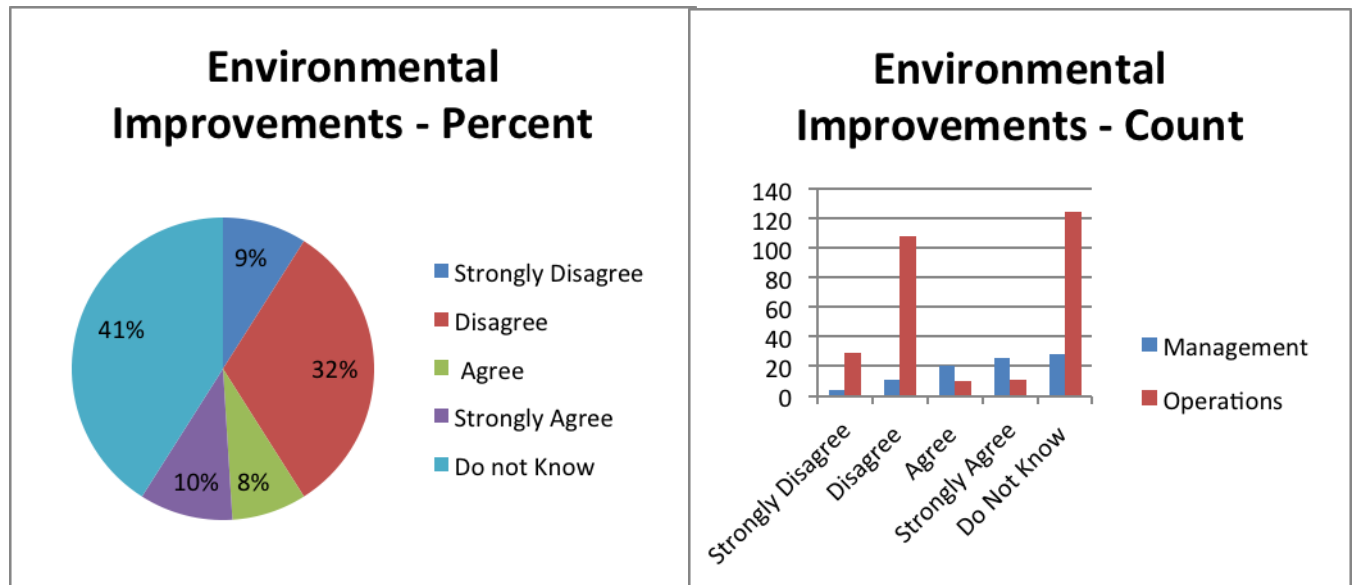


Figure 42: There is a drive for improvements and reduced environmental risks after implementing the EMS.

- **Benefits of EMS in the Facility**

Benefits of EMS question is a follow-up on Fig. 42 above which mainly focuses on the benefits of implementing the EMS at the facility. These benefits include, but are not limited to, saving costs, reduction in energy and water consumption, reduction in waste quantities, smart green purchasing, reduced raw materials consumption, and green environmental transport of materials and products. The respondents were asked whether EMS implementation saves cost on facility by achieving reduction in energy, water purchasing, raw materials consumption and transport. Fig. 43 illustrates that collectively around 48% (30% agree and 18% strongly agree) of the respondents believe that such benefits can be attributed to implementing the EMS, whereas 33% of the respondents do not know. Since this is a follow up question from the previous one, the expected statistical analysis of the two questions should reach similar conclusions. Most management staff agree on the benefits that EMS provides to the facility while the majority of operations staff are not sure about these benefits. A fair number of operations staff also agree on the benefits EMS add to their facility. By applying chi-square test to the set of responses obtained from management and operations staff, the chi-square statistic is 26.1748. The p-value

is .000029 which means that the result is significant at  $p < .05$ . Management and operations staff are different in agreeing on the benefits that the EMS adds to their facility.

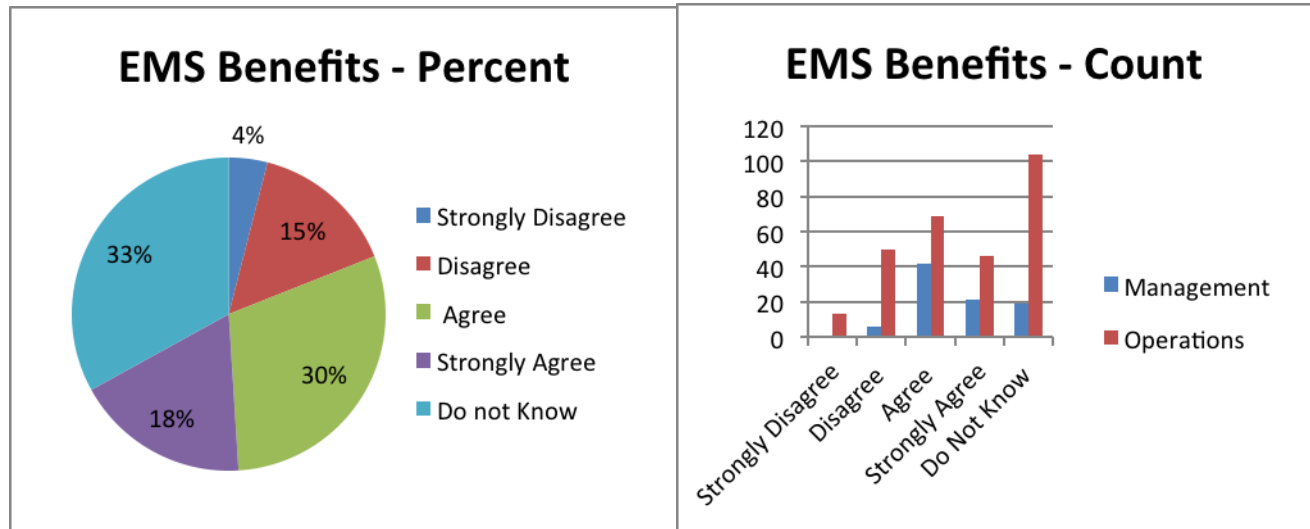


Figure 43: EMS Benefits including saving costs, reduction in energy, water and waste, purchasing raw materials and transport.

According to Fang & Zeng (2007), the benefits of the EMS for the industrial organizations can extend to several aspects besides environment related benefits. These include reduction in capital costs and energy consumption which help to enforce the sustainability concept in the operation process cycle.

- **EMS and Environmental Compliance Improvement**

One of the most desired outcomes from implementing the Environmental Management System (EMS) is meeting the legal requirements and improving the regulatory compliance. The respondents were asked whether EMS implementation improves legal environmental compliance with the regulator. Fig. 44 presents that the majority of respondents (44%) are uninformed whether EMS has improved the legal compliance with the regulator, while collectively 43% (27% agree and 16% strongly agree) of the respondents believe that such legal environmental improvements has been proven due to implementation of the EMS at the facility. Fig. 44 further illustrates the management and operations staff responses in relevance to improved environmental compliance due to EMS implementation. By applying the chi square test, it is evident the management and operations staff responses are different with regards to

environmental legal compliance and EMS implementation. The chi-square statistic is 20.7359. The p-value is .000357 which means that the result is significant at  $p < .05$ .

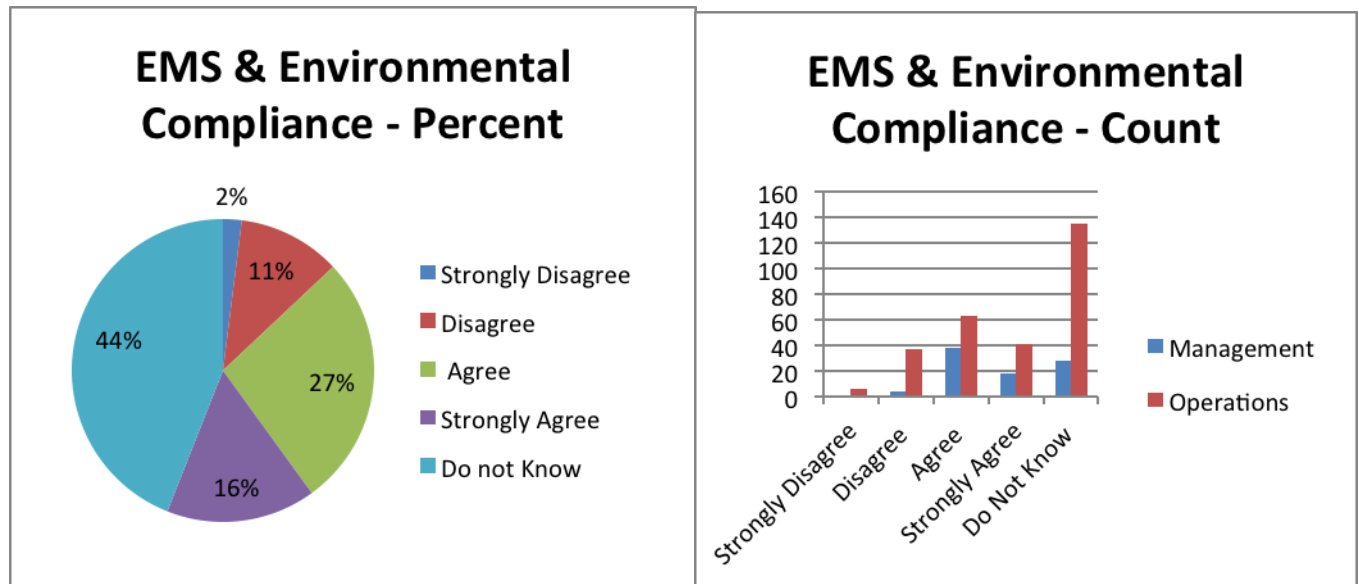


Figure 44: EMS implementation improved legal environmental compliance with the regulator.

Morrow and Rondinelli (2002) explain that environmental compliance should be considered in the operational facilities to enhance the compliance level. For example, the authors illustrate how the main reason that CEMS (Continuous Emissions Monitoring Systems) are installed at the stacks in many operational plants is to monitor emissions and ensure they are not exceeding the regulatory limits. In the end of their research work, the authors suggest that EMS should be utilized closely in a framework that achieves and guarantees legal environmental compliance in way that meets the business plans and the objectives of the organization.

- **Green Purchasing Availability in the Facility**

Stefan and Paul (2008) argue that improving the company's environmental performance has a positive impact on the economic and the financial performance of the company. While it may not particularly incur additional cost but it may open doors to opportunities. In fact, green purchasing and sustainable supply chain management may increase the company's competitive advantage in the market. This in returns has a positive impact on the application of the aluminium in the construction projects. Additional opportunities related to green purchasing include, but are not limited to, open access, investment and trade opportunities in foreign



markets, selling pollution control technology, risk assessment tools and techniques, and reduction of materials cost, energy, labor efforts, capital and services. For instance, Stefan and Paul (2008) discuss an example where aluminium production company (Alcan) developed and tested a process for Spent Pot-lining (SPL) treatment called Low Caustic Leaching and Liming (LCLL) process. Spent pot-lining is a hazardous waste generated from the smelting process and is generally stored or carefully land filled. In UAE, a small portion of this waste is recycled in cement industries while the majority of SPL is land-filled. Currently, Alcan is expanding their business by treating SPL for other aluminium companies. The aspect of SPL and its advantages and disadvantages will be further explored in the case study section of this research.

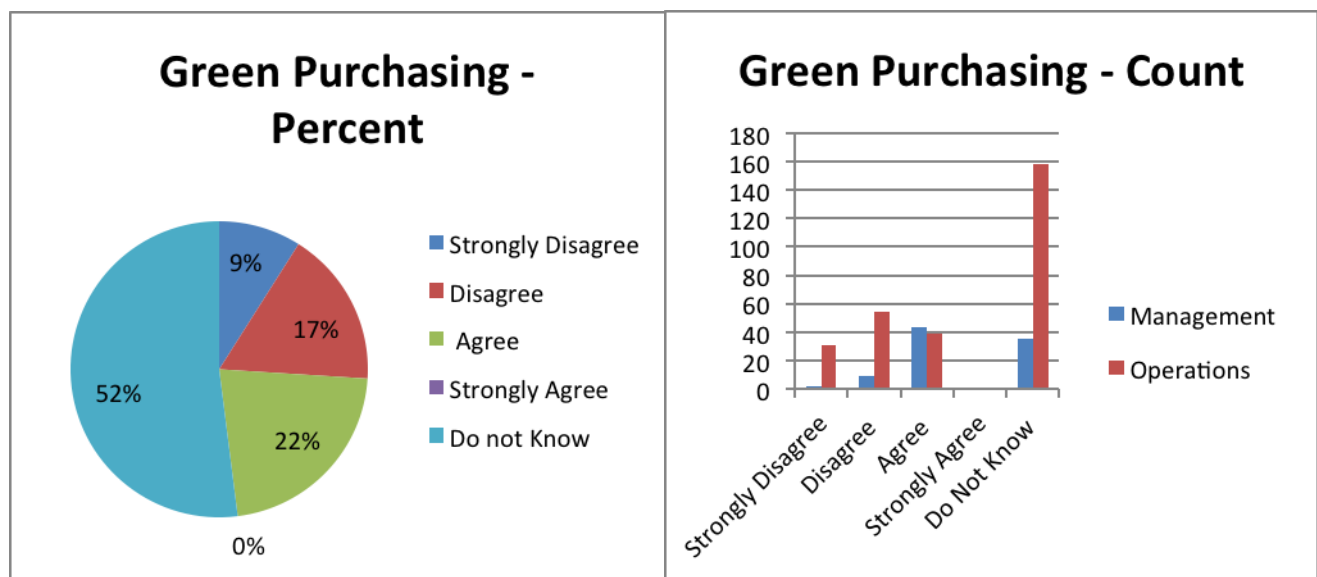


Figure 45: Green Purchasing and UAE Aluminium Industry.

Green supply chain management applies the concepts of monitoring and improving environmental performance in the supply chain by considering material resourcing and selection, manufacturing, logistics, product design and end of life management (Toke et al. 2010). The respondents were asked whether their facility's purchasing department uses a green purchasing policy. The right answer is that the company uses a green purchasing policy and that respondents should generally agree with this statement. According to Fig. 45, 52% of the respondents do not know whether their company uses a green purchasing policy, while 26% have indicated that the company does not habitually use a green purchasing policy for their raw materials purchasing.

Only 22% of the respondents stated that the company uses a green purchasing policy. The statistical analysis reveals that the two set of response from management and operations staff are different in answers to this question. The chi-square statistic is 49.2778. The p-value is  $< 0.00001$  which means that the result is significant at  $p < .05$ . Fig. 45 shows that large number of operations staff disagree or does not know whether their company uses green purchasing policy. While management staff mostly believes that their company is using green purchasing policy.

- **Corporate Social Responsibility (CSR) in the Facility**

Fig. 46 shows Corporate Social Responsibility (CSR) programs participation percentages for the facility. The respondents were asked whether their facility has corporate social responsibility programs such as clean up campaigns. There is a consensus about the company's participation in voluntary programs such as clean-up campaigns and corporate social responsibility events. The majority of the respondents (49% agree and 7% strongly agree) agree that CSR initiatives are evident and clearly demonstrated at the company whereas 33% of the respondents do not know and remained neutral. By analyzing the statistical significance of this question with relevance to the set of responses obtained from management and operations staff, it can be inferred that the two populations are different. The chi-square statistic is 11.8941. The p-value is .018157 which means that the result is significant at  $p < .05$ . Most management and operations staff through agree that there are corporate social responsibility programs at the facility; however, there is great number of operations staff who have "do not know" as a response.

Corporate Social Responsibility (CSR) can become reality if companies look beyond their sole profit-making interest and compliance requirements and focus instead on the moral, social and ethical standards by giving back to the community. According to Jenkins & Yakovleva (2006), CSR is about being involved at activities that benefits society. CSR strategies encourage business to improve the environmental conditions, stakeholders' management, interest and involvement. Pertaining to UAE aluminium Industry, there are certain annually held environmental and social events, such as clean up campaigns and sponsorship of certain sport events. UAE aluminium industry is quite active in such events and participate in them making the

memory of these social events last in the employee’s mind. This explains the high percentage of positive responses to this question.

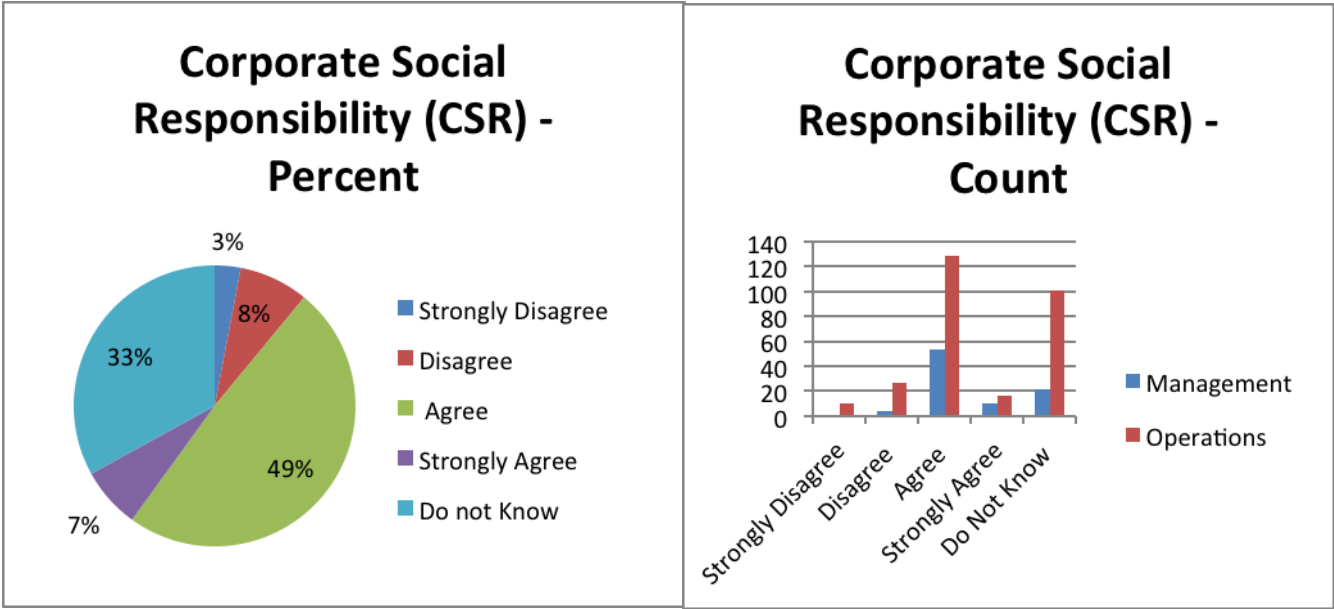


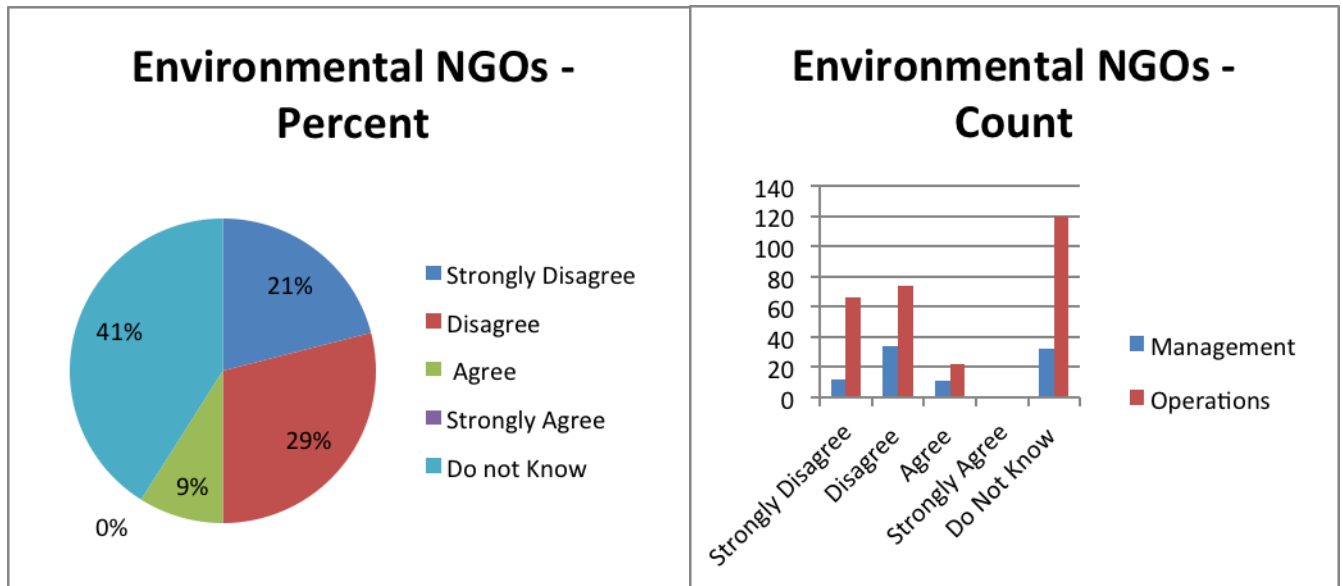
Figure 46: Industry’s Corporate Social Responsibility and Participation in Voluntary Programs.

- Environmental Non-Government Organization Involvement at the Facility**

The respondents were asked whether their facility solicits opinions from environment non-profit organizations and involves them in site planning or in identifying environmental impacts. Fig. 47 identifies percentages of respondents’ opinions on environmental non-governmental organizations involvement at site planning of the facility and the process of identifying its environmental impacts. 41% of the respondents have indicated that they don’t know whether their company contacts environmental NGOs or even involves them at site selection and planning stage. Around 50% of the respondents indicated that their facility definitely does not involve environmental NGOs in consultations or operations. This great percentage indicates that there is no direct open communication channel between aluminium industrial facilities and local environmental NGOs. In fact, the role of environmental NGOs and any public related stakeholders in UAE is unpleasantly limited as they are not empowered by government sector. This is prevalent globally due to the nature of their role in opposing pollution

causing industries and activities. For example, according to Cellariu and Staddon (2002), the factors affecting the role of the NGOs can include social and cultural context, government imposed pressure, educational level of the citizens and political context in the country.

Moreover, the authors believe that there are many benefits in involving the environmental NGOs and public stakeholders in site selection, planning and identifying environmental impacts at the facility. For example, the most commonly used environmental tool to collate opinions from the public sector and environmental groups is the Environmental Impact Assessment. When doing the EIA, public consultation is of great importance as it can steer the project to suit public requirements and increase their awareness (O’Faircheallaigh 2010).



**Figure 47: Soliciting opinions from Environmental Non-Governmental Organizations (NGOs).**

The statistical analysis with regards to this question indicates that the two categories, management and operations staff, are different. The chi-square statistic is 8.7909. The p-value is .032205 which means that the result is significant at  $p < .05$ . Most operations staff either “do not know” or “disagree” that the environment NGOs role is active at their facility while management staff almost shares the same opinion with more focus on the “disagree” opinion. In fact, it is expected from operations staff to not have the full understanding of the environment NGOs role particularly as their role in the UAE is inactive.

- **Facility's Objectives Towards Significant Environmental Aspects**

Fig. 48 discusses the respondents' knowledge on whether there are objectives set for significant environmental aspects at the facility. The right answer is that the facility sets objectives and targets to manage significant environmental aspects and that respondents should generally agree with this statement. Aspects of environmental significance at the aluminium production facility include air, water, solid waste, hazardous waste and noise. It is vital to have clear Environmental Management System (EMS) objectives that are evaluated regularly and are shared with all employees inside the facility in order to help them with the EMS implementation process. According to Sharma (2000), having generic and broad environmental management scheme without specific targets can be distracting for the employees and can affect the communication channels responsible for implementing the environmental management inside the operational facility. The author suggests that the communication and systems' evaluation cannot be efficient if there are no explicit Key Performance Indicators (KPIs) in place. Usually, most organizations extract such KPIs from the preliminary objectives. Fig. 48 results strongly indicates that environmental objectives are not visible for most of the operational workers where the respondents' either disagree (41%) or do not know (37%) about the current objectives. By analyzing the statistical significance of this question with respect to the set of responses obtained from management and operations staff, it can be concluded that the two populations are not different. The chi-square statistic is 4.9203. The p-value is .295576 which means that the result is not significant at  $p < .05$ . Most management and operations staffs either do not know or disagrees about the fact that the facility sets objectives for all the significant environmental aspects.

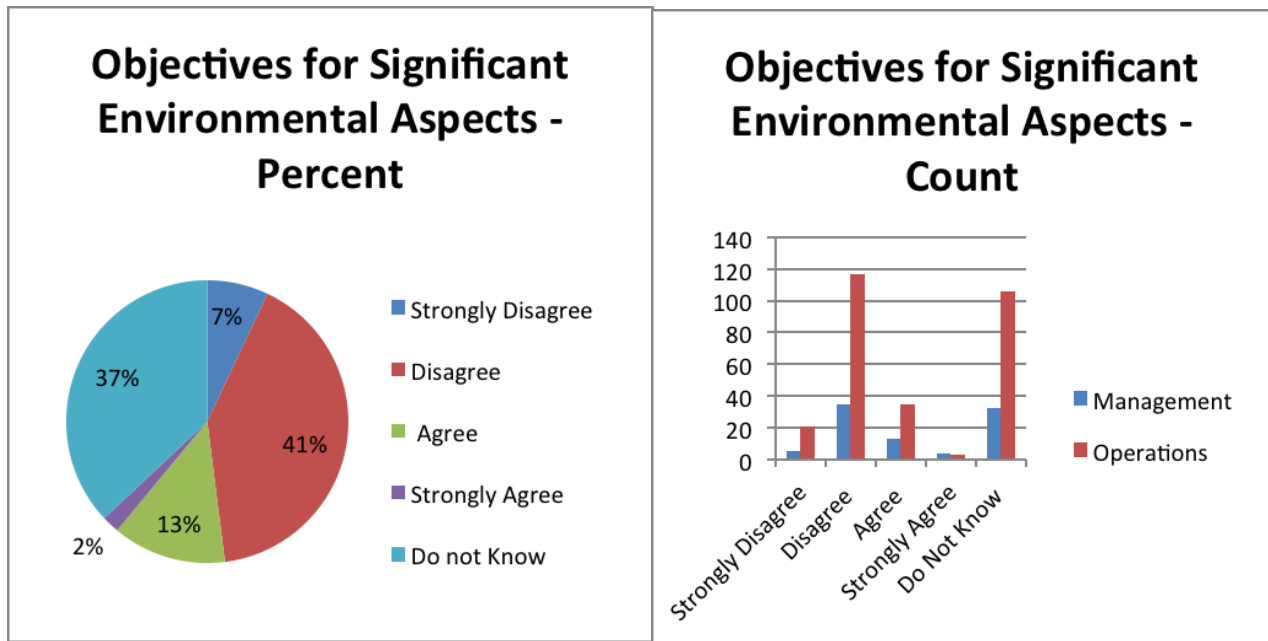


Figure 48: Objectives and Target Setting Process for Significant Environmental Aspects.

Overall, Environmental Management System (EMS) evaluation section of the questionnaire shed some light on the current EMS practices in the UAE aluminium industry. In some questions, there were obvious differences between the management and operational staff responses, while in other questions the responses from the two groups yielded similar conclusions. The third section of the questionnaire follows and discusses the opinion based questions of the questionnaire.

### 4.1.3 Opinion Based Questions

#### A. Value of EMS

Fig. 49 explains the respondent's perspective towards the various values that Environmental Management System (EMS) can provide inside the operational plant. This question has three different options: little, moderate and high where the employee can estimate the value of the statement with regards to EMS. Fig. 49 displays that most respondents selected achieving compliance (73%) and company reputation (63%) as the highest values of the EMS in their operational plants. It is worth noting that most of the management responses come from employees holding managerial posts inside the organization. According to Vachon and Klassen (2008), many manufacturing and operation managers deal with EMS as documentation process that they need to be compliant with in order to enhance the organization image and reputation

which is considered a positive attitude from the management. However, the authors believe that because of this non-integrated and fragmented vision of EMS, the system performance may be affected which is considered as the core purpose of this environmental scheme. Vachon and Klassen (2008) suggests that operation managers tend to neglect the EMS performance if their facilities satisfy the legal requirements and regulation; however, in order to have an efficient EMS system, a balance management approach between documentation, compliance and performance should be applied. Moreover, Fig. 49 indicates how 62% of the employees support of the idea that EMS can enhance the project management implementation. Simultaneously, Fig. 49 shows some negative numbers that can raise several questions regarding the EMS implementation at the aluminium operational facility. For example, there are disputes and disagreement about the role of EMS in enhancing the environmental behaviors of employees and managers at the operation plant and this is obvious from the equivalent percentages (36%, little and 38% high). It can be inferred that employees did not link the EMS with environmental behavior at the plant. Ideally, this should not be the case according to Barr (2003) as one of the major goals of the environmental system implementation is to enhance the environmental behavior at the desired organization.

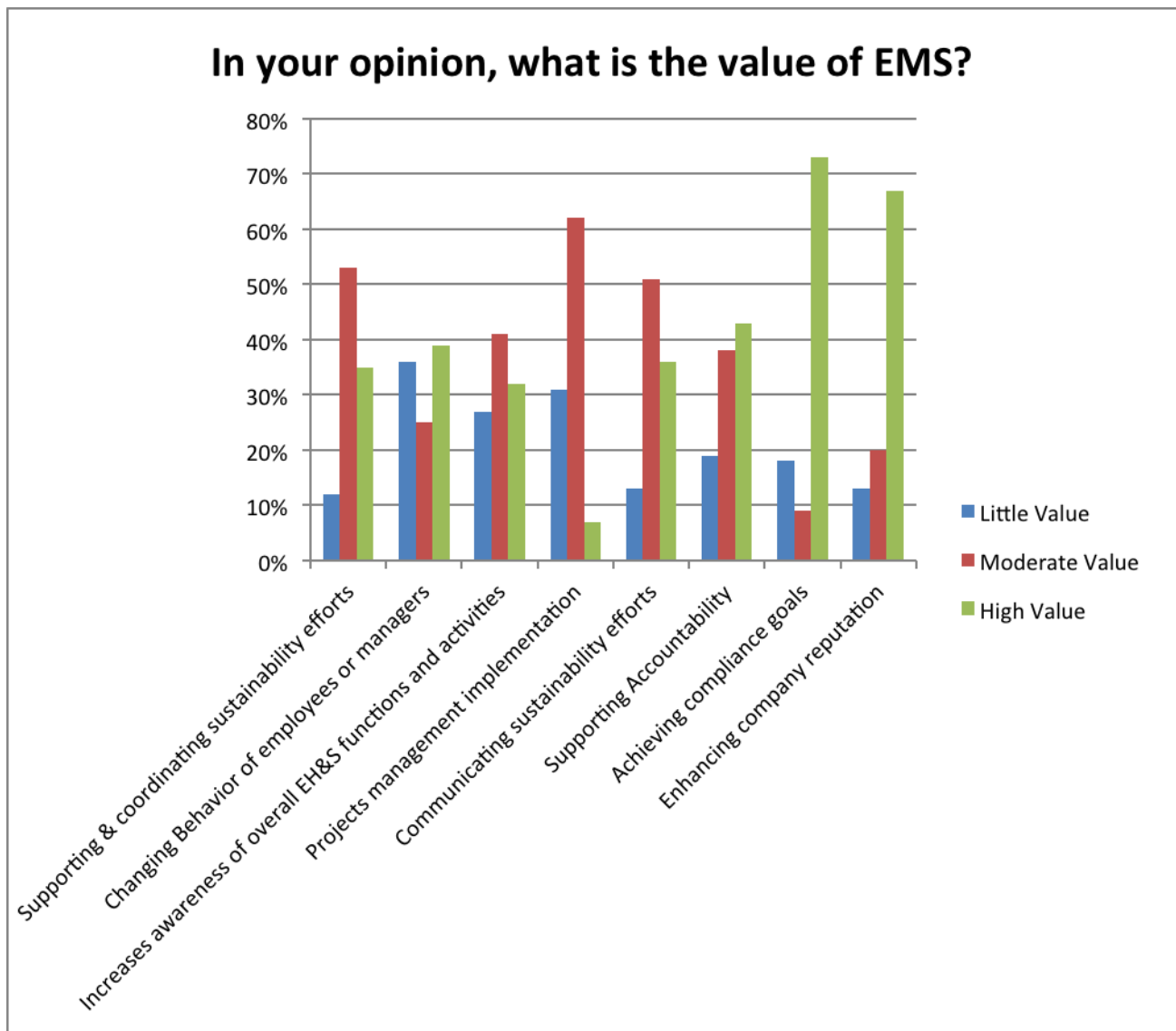
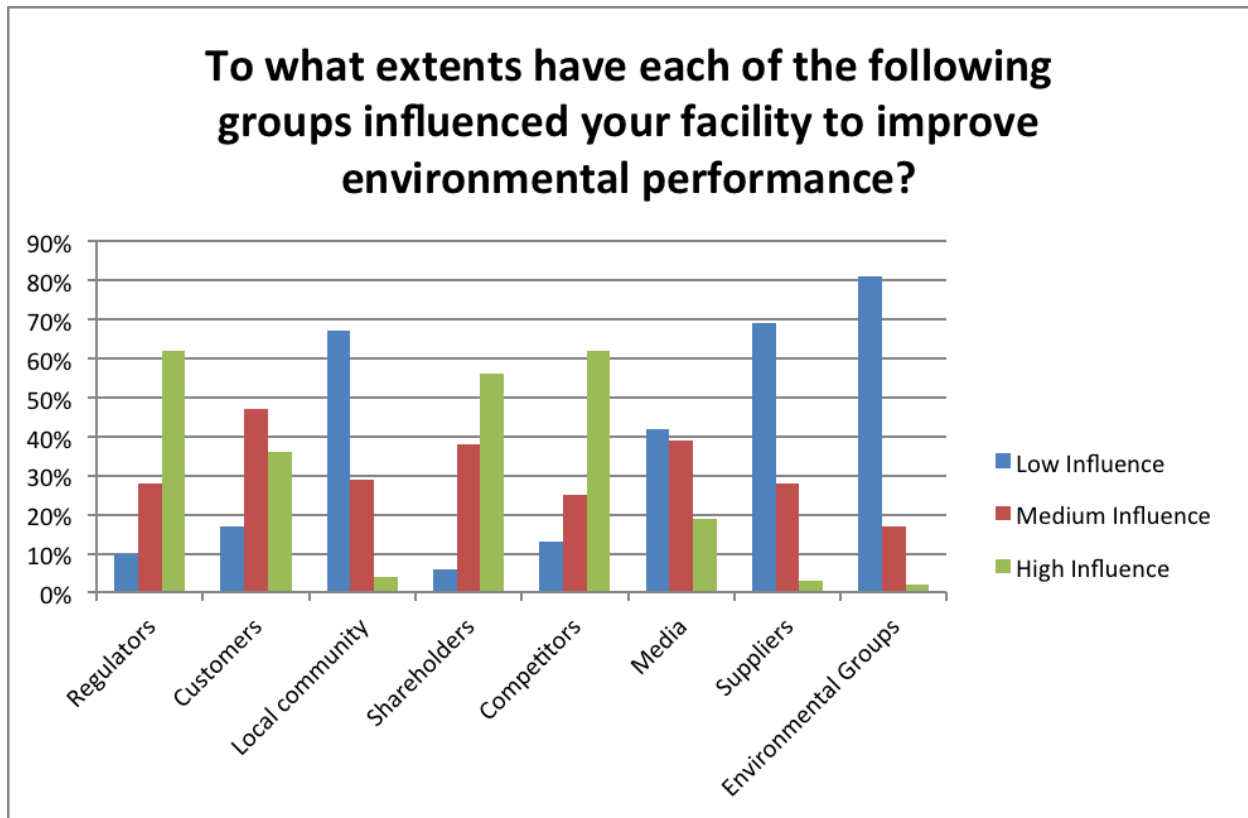


Figure 49: EMS value in your operation facility.

## B. Groups Influencing Environmental Performance

This question tries to examine the external stakeholders that can influence the industrial professionals to act and operate with respect to the environmental matters for short and long term. Fig. 50 describes that many respondents believe that there exists a major absence of environmental groups and local community role in influencing the environmental performance at the operational plants. To illustrate, the employees indicated a low influence response as 81% and 69% for environmental groups and local community respectively in which these results display a lack of involvement and communication between these groups and the industrial facilities.





**Figure 50: Group influenced your facility to improve environmental performance.**

Florida and Davison (2001) conducted a research work that explores the internal and external factors affecting the implementation of Environmental Management System (EMS) inside the operational organizations. They conclude that poor involvement of environmental society groups has a significant impact on the implementation of the environmental system. The authors mention that environmental society groups present an outsider point-of-view that reflects the community's environmental needs. Such point views aid industrial sectors in designing a specific framework that covers the current environmental challenges in the surrounding area. In addition, Fig. 50 reflects a positive indication and perspective about the regulator's influence where most of the respondents (62%) selected regulators as one of the highest influencing groups on industries. This shows an optimistic view of how legislations and regulations can enhance the environmental performance at aluminium operational plants. Telle and Larsson (2007) believe that environmental laws and regulations are factors affecting the process of environmental compliance at the aluminium manufacturing facility. The authors illustrate that most of the operation plants tend to comply with regulations to avoid legal actions or fines that can be issued from government authorities in case of non-compliances. The regulators typically ensure

compliance by conducting regular audits and inspection for the aluminium manufacturing plants. Moreover, the authors highlighted that compliance with the legislations will encourage the industrial firms to have positive competitive advantage between them in a way that makes their operational processes more green and sustainable.

### **C. Environmental Improvement Motivation Factors**

Govindarajulu and Daily (2004) believe that environmental motivation is an important factor for all employees from management to operational level. Here, the motivational drive to implement Environmental Management System (EMS) can differ from one operational facility to the other. For example, the authors mention that many of the operational facilities adopt the EMS to become ISO 14000 certified and this recognition aids in gaining a better reputation in the local and international markets. This political/economic drive is reflected in Fig. 51 where 89% of the respondents selected compliance to regulatory system as the main motivational factor for implementing the EMS. In addition, the responses show that having new products and services can be another important environmental motivation factor that helps the organizations attract more customers, especially those who desire to have more sustainable products incorporated in their operational activities. Unfortunately, the gaps between the Environmental Non-Governmental Organizations (NGOs) and industrial companies arise again in Fig.51 where 65% of the respondents do not see any importance of improving the NGO relationship as environmental motivation for their facilities. However, Wiengarten etl al. (2013) suggest that the real motivation for the industrial companies should come from an ethical standpoint that considers the safety and health of the employees and the surrounding area. The authors explain that the orientation of management plays a critical role in the adoption of EMS implementation where ethical motivation acts as a trigger that initiates the ISO 14000 Environment Management System. In general, Fig. 51 explains that industrial firms do invest in obtaining ISO14001 certification to enhance their operation's environmental performance; however, this is often done for not the right reasons. EMS is being miss-utilized for its purpose where senior managers consider ISO 14001 certification as a display of a functioning EMS and exceptional environmental performance.

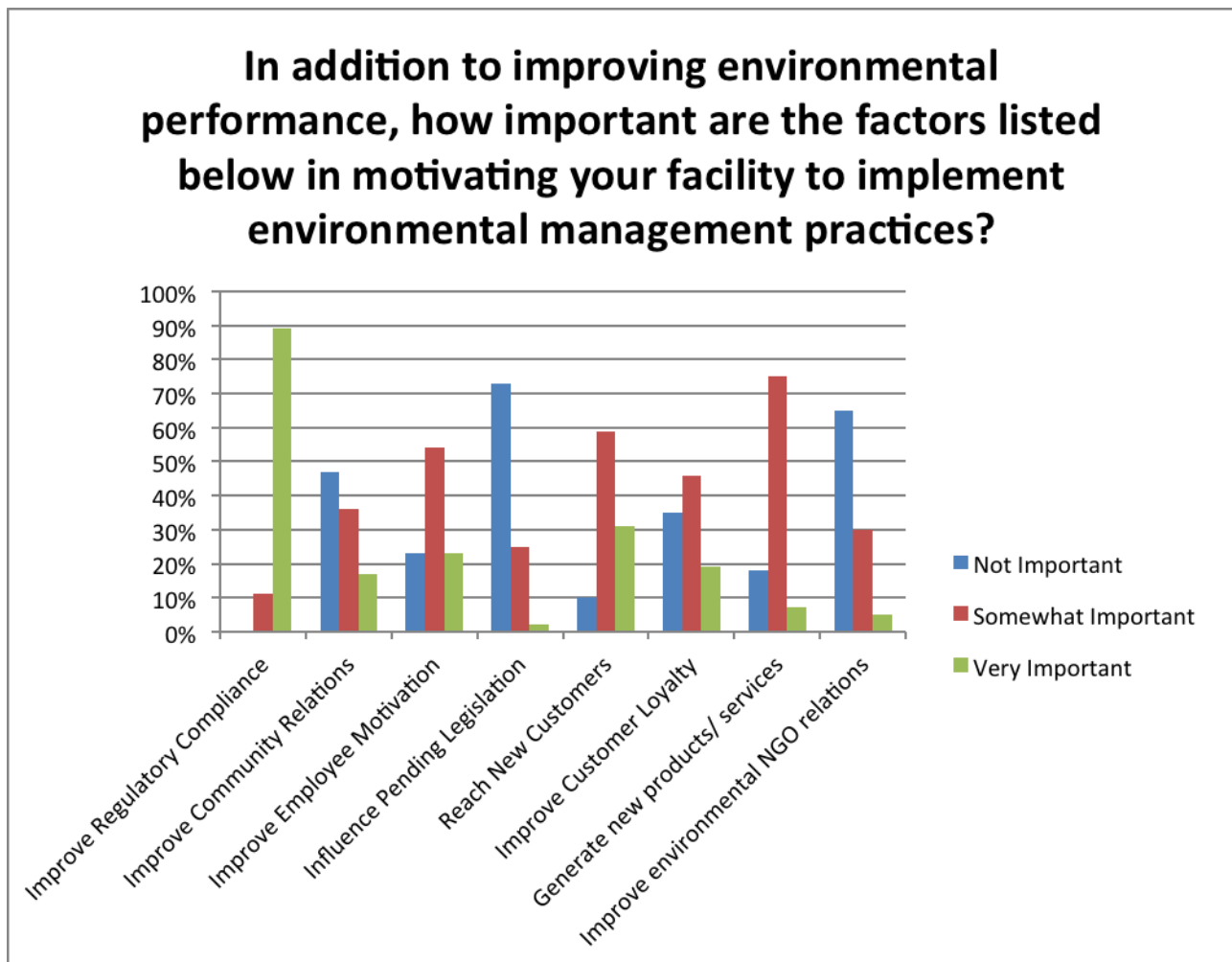


Figure 51: Environmental motivation in your facility.

#### D. EMS Implementation Experience

Fig. 52 contains statements that best describe the respondent's Environmental Management System (EMS) implementation experience. It was noted that a large percentage of the respondents (39%) indicated that they have seen limited EMS improvement while 20% of the respondents confirmed that a formal EMS has not been actually implemented. Zutshi and Sohal (2004) explain that even if there is an EMS system operating in-house, it is only through continuous improvement that real environmental enhancements can be achieved. For example, the authors believe that the environmental lessons learnt that occur inside the operation facility should enable senior managers to seek improvements in the organization processes and procedures so that they can comply with the "continuous improvement" clause of the EMS standard.

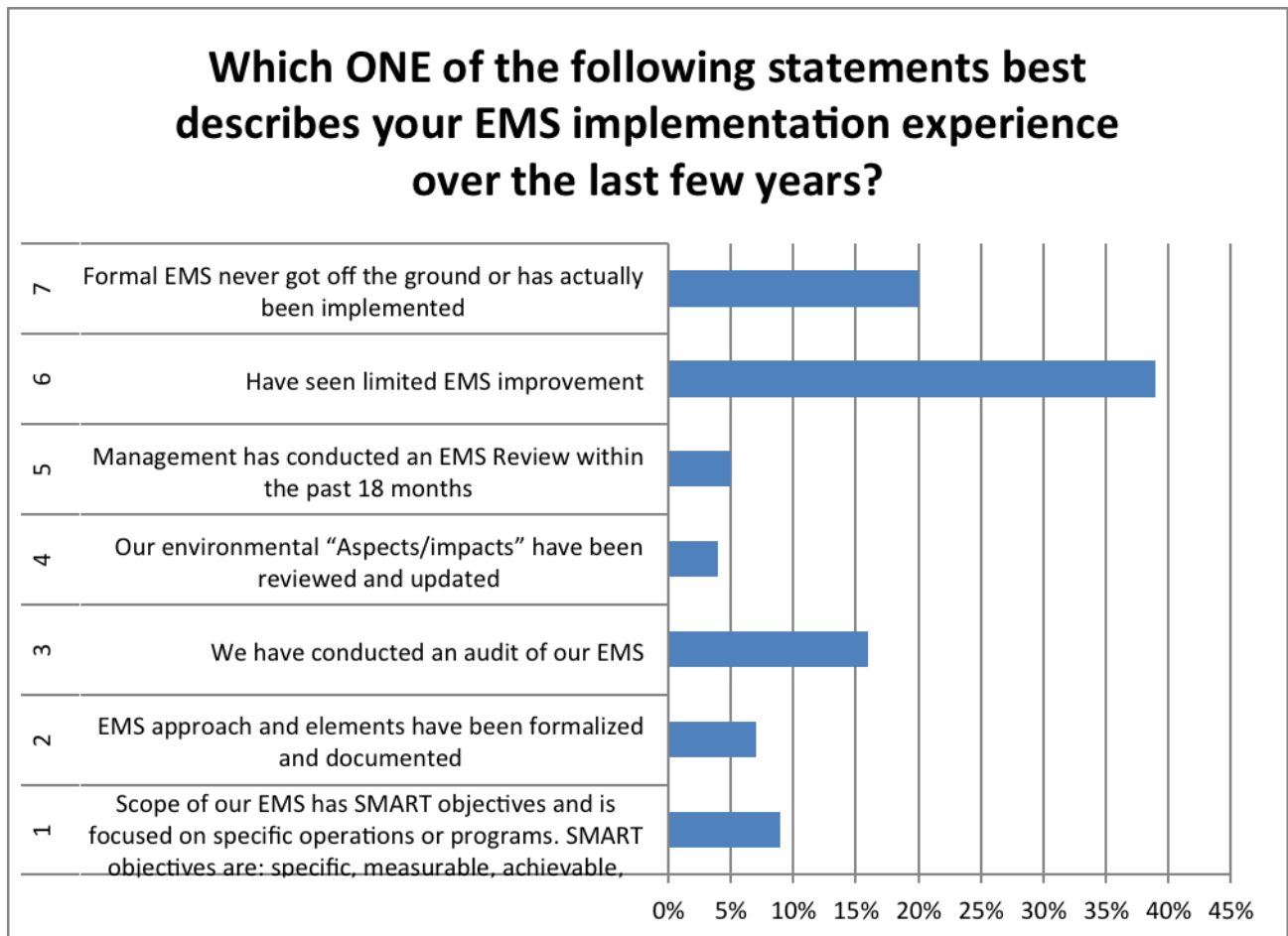


Figure 52: Description of EMS implementation experience over the Last few years.

As displayed in Fig. 52, limited Environmental Management System (EMS) improvement is noticed as the environmental aspects and impacts of the industry undergo little or no review in the UAE aluminium industry. Continuous improvement involves a constant incremental improvement of a product, service or process at the facility. It can be achieved through annual management review of the EMS, expert staff EMS validation and implementation, along with research, development efforts and technological enhancement. As such, many environmental professionals encourage operation firms to have an integrated framework for EMS that include continuous improvement element to ensure enhanced EMS implementation process at the manufacturing phases. Theyel (2000) mentions that continuous improvement is not only important for EMS to enhance the quality of the compliance performance but it also helps in updating all environmental technologies that environmentally improve the entire production process.

## E. External Factors Affecting EMS

Fig. 53 ranks the external factors affecting the implementation of the Environmental Management System (EMS) while percentages represent the number of occurrences the factor has occupied the rank. Respondents have ranked bureaucratic work as the highest external factor affecting the implementation of EMS. According to Pérez et al. (2007), bureaucratic practices have a major impact on the EMS implementation, especially if they occur at the communication and approval system in which they can delay the processes and de-motivate employees.

The second external factor affecting the implementation of Environment Management System (EMS) is the lack of support, followed by the third external factor affecting the implementation of EMS which is weak enforcement. As per Fig. 49 and Fig. 50, although respondents in the questionnaire expressed that laws and regulations enforcement can be one of the most important factors that help workers to implement EMS at the workplace, laws and regulations can only work if there is a robust enforcement and monitoring system. Lack of adequate regulations is a significant factor as it leads companies to lower investments on sustainability and environmental technologies. If there is ineffectual enforcement from the authorized monitoring sectors, this will create a procrastination culture towards fulfilling the environmental management requirements and commitments at the operation facilities. According to Percival et al. (2009), effective environmental enforcement needs to be executed from all responsible parties i.e. operation and government organizations. As such, it is vital to have specific government environmental specialized agencies whose role is to ensure effective enforcement. Simultaneously, the authors suggest that such agencies should establish and publish compliance standards that can provide visible guidelines and drives for industrial sectors. Unfortunately, this is not the case in UAE aluminium industry, as demonstrated by Fig. 53. For instance, the fifth, sixth, and seventh external factors display a major lack in standards and guidance needed to implement EMS at aluminium manufacturing plants in the UAE.

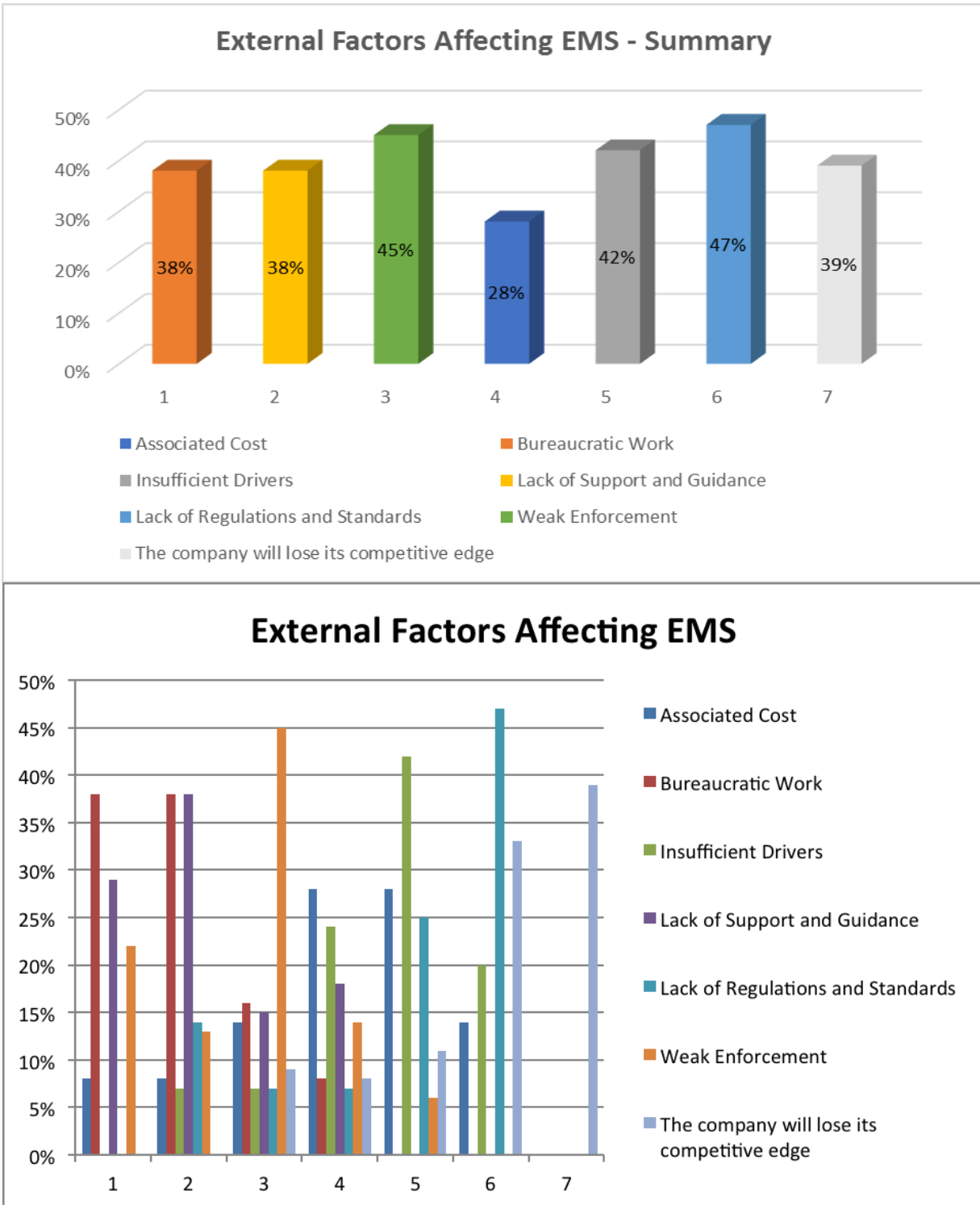
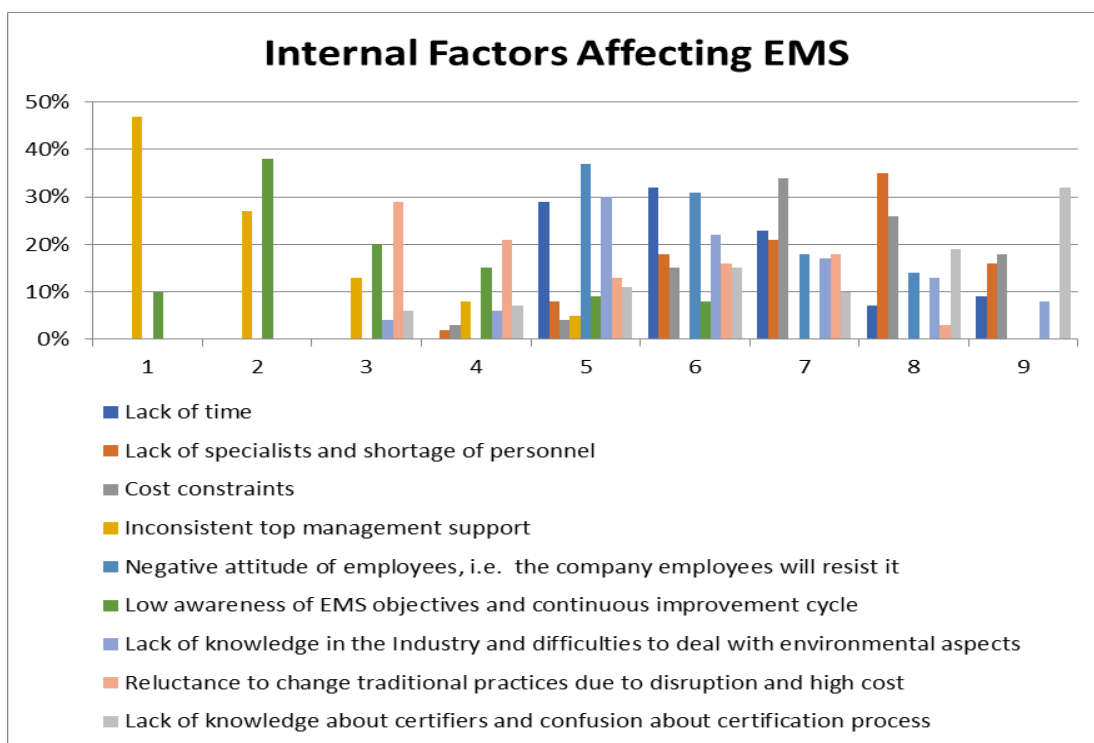
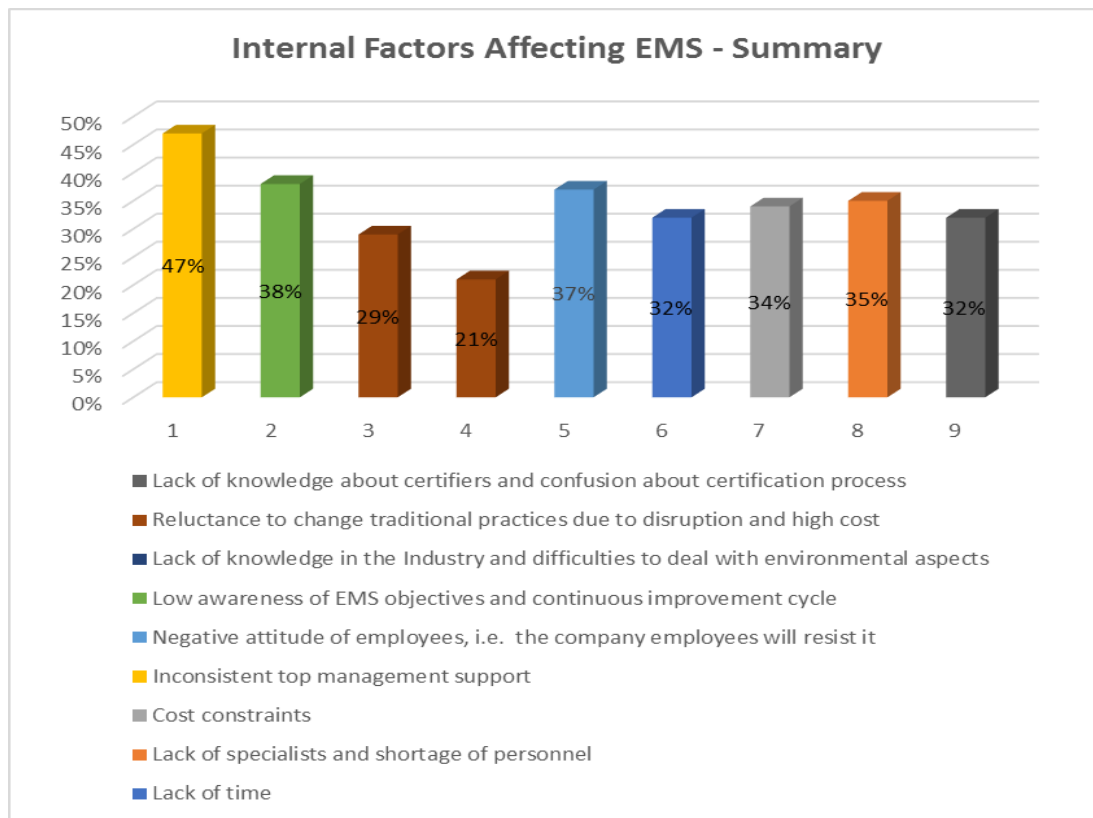


Figure 53: Rank of external Factors affecting the implementation of EMS.

## **F. Internal Factors Affecting EMS**

Fig. 54 explains the ranking of internal factors affecting the implementation of the Environmental Management System (EMS) while percentages represent the number of occurrences the factor has occupied the rank. Around 47% of the respondents indicate that inconsistent top management support is the top internal factor affecting the implementation of EMS. According to Christmann (2000), the most important internal practice to implement EMS is the demonstration of the environmental leadership which should be raised from the top management inside the workplace. The author believes that “best practices” in environmental management always requires “a lead by example” approach where employees can follow someone who is committed to sound environmental practices at the operation plant. As such, practicing environmental leadership is crucial because it not only trains the employees to be compliant with environmental regulations but it also encourages the operational staff to enhance their professional skills to stay competitive through the application of EMS. This is why the author suggests that environmental leadership adoption is an influential key internal factor for EMS implementation.

The second internal factor affecting the implementation of the Environmental Management System (EMS) is low awareness of EMS objectives and continuous improvement cycle. This result is consistent with all other results in Fig. 50 and Fig. 51 where this exposed the need for effective application of laws and regulations enforcement at the operation facilities by government authorities. According to Schwartz (2003), in environmental management, awareness and enforcement are closely related with each element directly affecting the performance of the industry. The author illustrates that if there is more awareness about ISO 140001 clauses through different internal firm channels, there will be more enforcement and vice versa. However, Schwartz advises that many organizations are unwilling to spend resources to raise the environmental awareness because they think it is the responsibility of the external government authorities. The respondents display this opinion in their responses where they have chosen the reluctance to change traditional practice due to disruption and high cost, as the third and fourth internal factor affecting the implementation of EMS.



**Figure 54: Rank of Internal Factors Affecting the Implementation of EMS.**



From the fifth factor to the ninth one, Fig. 54 sheds light on factors which are related to the human behavior and attitudes. Here, negative attitude of employees ranked fifth in terms of internal factors affecting the implementation of the Environmental Management System (EMS). Employees often resist the EMS implementation and the changes associated with their daily processes due to EMS. Zeng et al. (2005) stress that in order to have a successful EMS implementation process, positive attitude of employees is essential. In their survey work, 76% of the respondents indicated that the surveyed companies' employees who had a positive attitude towards EMS are mostly front-line employees who are not exposed to the dirty and polluting manufacturing process. Rather, these positive attitude employees are associated with support services such as recruiting which in turn attracts more employees owing to the high environmental standards.

Lack of time was chosen as the sixth internal factor affecting the implementation of EMS. TSE, R. Y. (2001) explain how developing and maintaining the Environmental Management System (EMS) costs time and money. Setting up and implementing EMS can take up to two years depending on the type of the industry. These two years include vigorous staff training and heavy documentation process to keep and update records.

The seventh internal factor affecting the implementation of the Environmental Management System (EMS) is cost constraints. TSE, R. Y. mentions that expensive EMS implementation cost is ranked as the third barrier in implementing the ISO 14001. However, the author raised an important remark that although some preliminary cost is required to set up the EMS implementation and certification process, there are indirect rewards for the environment and the budget. These include reduction of waste, emissions and fuel consumptions, and energy conservation.

The eighth internal factor affecting the implementation of the Environmental Management System (EMS) is lack of specialists and shortage of personnel. McKeiver and Gadenne (2005) mention how often a limited staff number and lack of specialists hinders the process of allocating specific personnel to handle environmental issues. The ninth internal factor affecting the implementation of EMS is lack of knowledge about certifiers and confusion about certification process. For example, Zhu and Sarkis (2004) point out that a lack of knowledge about certification process and requirements can directly impact the performance of the EMS at

the company. When comparing EMAS and ISO 14001, EMAS certification requires reporting environmental effects and legal requirements at the site while ISO 14001 makes certification voluntary where companies can decide on EMS verification and disclosure requirements. This is why more companies are inclined to register with ISO 14001 as a private registration as opposed to waiting for the state to register the company with EMAS. The freedom, flexibility and tailoring to needs approach has made ISO 14001 more competitive and prevalent across profit making organizations.

## **4.2 Questionnaire Results Summary**

Survey results display major gaps in the Environmental Management System (EMS) implementation process at the aluminium industry in UAE. Lack of awareness on issues related to EMS implementation was evident in almost all responses along with a weak enforcement of the regulations. The most interesting result obtained is that respondents exhibited a tendency for improvement and a quest for knowledge about environmental requirements. Moreover, inconsistent top management support was ranked as the number one internal factor affecting the implementation of EMS, reflecting a major leadership gap. It is worth noticing that bureaucratic work was ranked as the number one external factor affecting the implementation of EMS, highlighting the complexity of the external relations with government authorities.

It can be concluded from the surveyed population demographics in Fig. 21 to Fig. 26 that most of the respondents are male. The majorities of respondents also possess a Bachelor degree and work in manufacturing and operations fields. Thus, the targeted population is achieved where most of the respondents are the technical staff working within the operational units of the UAE aluminium industry.

On a positive note, the questionnaire shows that the surveyed employees see the value of implementing the Environmental Management System (EMS) on the technical aspects, such as reduced environmental impacts or the branding, and marketing aspects, such as enhanced company image, as can be seen in Fig. 41 and Fig. 43. Additionally, the majority of respondents highlighted that they do receive environmental based training and companies do offer environmental training courses (Fig. 34). However, the quality of the provided environmental training is questionable as it has failed to significantly increase employees' environmental

awareness on EMS related issues (Fig. 27-31). It can be inferred that the provided training is not specific enough or at the very least is not tailored to the employees' needs.

Many employees lack the basic knowledge regarding the existence of the Environmental Management System (EMS) at their facility, see Fig. 27-31. As highlighted in Fig. 42, this can be attributed to the lack of motivation for environmental improvements. Moreover, low awareness on environmental objectives and continuous improvement cycle settles for second place as the most influential internal factors affecting the implementation of EMS. Therefore, this confirms that awareness of EMS and environmental issues at the facility is deemed relatively low. On a personal note, by going to the facility site location to collect responses, a great deal of environmental training and education had to take place in order to familiarize employees and operational staff on the nature of the survey and the intended purpose. The environmental knowledge and awareness of employees is often low can also be attributed to the high operational staff turnover rates at industrial sites; which emphasizes the importance of continuous awareness and job-specific environmental training.

Another major issue revealed as result of this survey is the weak communication between the industry and the non-governmental organizations (NGOs) and environmental groups. The lack of communication between these institutions is a common world-wide problem. The reason is that the environmental NGOs have the tendency to oppose and object on the industrial activities that impact the environment and the society. However, this is of particular interest in UAE as the role of NGOs and environmental groups is not active. Other countries do involve NGOs in industrial site planning and consider their feedback as valuable, particularly in the Environmental Impact Assessment (EIA) preparation process. The EIA experience in UAE, on the other hand, does not include public, stakeholders and NGOs consultation process.

The questionnaire also highlighted other organizational defects and challenges in implementing the Environmental Management System (EMS) such as the lack of funding, as explained in Fig. 36. The absence of transparent leadership is also a major barrier to implementation of the EMS, as shown in Fig. 39. The same result was reflected in Fig. 54 were inconsistent top management support is ranked as the most influential internal factors affecting the implementation of EMS. Furthermore, as shown in Fig. 52, the EMS implementation process in the industry has remained stagnant with no continuous improvement. These major challenges

reveal the needs of employees working on site to get a better understanding of the internal and external factors affecting the implementation of EMS. Moreover, to understand how the EMS operates and what can be done to improve the implementation of the EMS, there is a need to conduct a specific UAE aluminium industry case study to verify the questionnaire responses.

With regards to statistical significance, many questions in the Likert scale indicate a significant difference between management and operations staff. These stress the fact that these two populations are essentially different. However, few questions have shown that management and operations staff agree on the following statements:

- Majority of management and operations staff disagree with the visibility, accessibility and the well communication of the environmental policy which means that the environmental policy is evidently not as described above.
- Majority of management and operations staff agree that there is lack of accountability in fulfilling the set objectives and targets.
- Majority of management and operations staff agree on the benefits of marketing and branding in adopting the EMS through increasing the number of clients and expanding business
- Majority of management and operations staff disagree on the statement that the aluminium smelting facility set targets and objectives for all the significant environmental aspects including air, water, solid waste, hazardous waste and noise.

Mainly, these statements are considered true as the responses indicate because the management and operations populations agree on them. The above-mentioned statements are clearly linked to the previously mentioned gaps in terms of environmental training and awareness. Table 7 below lists further the significant and independent factors affecting the obtained responses from a statistical view point. Statistically significant factors ( $P\text{-value} < 0.05$ ) in the first column means the respondent status is dependent on this factor while independent factors ( $P\text{-value} > 0.05$ ) means that respondent status is independent of this factor.

**Table 7. List of Statistically Significant Factors and Independent Factors Affecting the Implementation of EMS in the UAE Aluminium Industry (Refer to Section 3.4).**

<b>Significant Factors</b>	<b>Independent Factors</b>
1. Lack of awareness on issues related to EMS implementation and weak enforcement of the regulations	1. Environmental policy is visible, accessible to all staff and well communicated
2. Inconsistent top management support and absence of transparent leadership	2. Lack of accountability in fulfilling the set objectives and targets
3. Bureaucratic work affects implementation of EMS	3. Facility benefits from the marketing and branding in adopting the EMS by increasing the number of clients and expanding business
4. Environment Training affects the implementation and awareness of EMS	4. Targets and objectives for all the significant environmental aspects including air, water, solid waste, hazardous waste and noise
5. Weak communication between industrial companies and the non-governmental organizations (NGOs) hinders EMS external outreach	
6. Lack of funding affects the implementation of EMS	

In the conclusion of this section, the questionnaire survey exposes some internal and external influences that may impact the implementation process of EMS as Table 7 displays. Yet, to have a holistic view about the root causes behind these influences, further investigation is required. Highlighting and understanding the root causes will aid this research study to provide effective and resilient solutions to the EMS implementation gaps. For example, it is vitally important to know why most of respondents believe there is weak communication between industry and (NGOs). In addition, the questionnaire demonstrates some critical technical defects that have major role in implementing a healthy EMS in the work place i.e. lack of knowledge and environmental training. As result, additional examination approach is preferred to address all the challenges that were shown in the survey phase.

## Chapter 5: Case Study

### 5.1 Introduction, Structure and Approach

The case study is undertaken in Emirates Global Aluminium (EGA) that covers two major smelter sites in the UAE, DUBAL and EMAL. Verification interviews and testimonies from employees working within these two sites allowed for a closer analysis of the Environmental Management System (EMS) questionnaire results. Onsite walkthroughs in DUBAL premises during the March 2016 helped gather data on the structure and the efficiency of EMS, while the July 2016 was dedicated towards gathering data on the EMAL site. Exposure to management and operational employees made for contrasting responses. It is also noted that due to the confidentiality of the nature of these interviews, interviewed subjects remain anonymous.

Under Emirates Global Aluminium (EGA), 2.34 million tonnes of primary aluminium products were manufactured in 2014. The total EGA staff number is 6,750 employees and the total recordable injury frequency rate at UAE operations in 2014 was 3.52, as reported by EGA management. The Fluoride emissions measure at 0.352kg/t Al compared to an industry average of 0.59 kg/t Al. Similarly, PFC emissions measure at 0.082 t CO<sub>2</sub> eq/t Al compared to an industry average of 0.27 t CO<sub>2</sub> eq/t Al. The operating amperage of the DX+ reduction cell technology is 450kA and the energy consumption is 13.27kWh/t Al compared to an industry average 14.56kWh/t Al. Such data are combined and reflected in both sites, DUBAL and EMAL records.

DUBAL industrial smelter site began construction in 1976 and has officially started production in 1979. It is located in Jebel Ali Industrial Village, Dubai. Soon after, an industrial port was built near the site to support the smelter activities and a desalination plant was coupled with the complex. Additionally, a stand-alone gas plant was added to supply the aluminium industry with the required gas for running its operations. DUBAL has also 1573 reduction cells in 7 pot lines and 3 cast houses. EGA, in general, supplies the automotive industry, construction, industrial, transportation and automotive forging, electronic and aerospace with the required metal alloy, billets and high purity aluminium. Around 23.5% of produced aluminium goes into construction sector, as can be seen in Fig.55. The demand for aluminium in construction has

increased by 20% in 2004 to 23.5% in 2011. This indicates the relative increase in construction activities in the region.

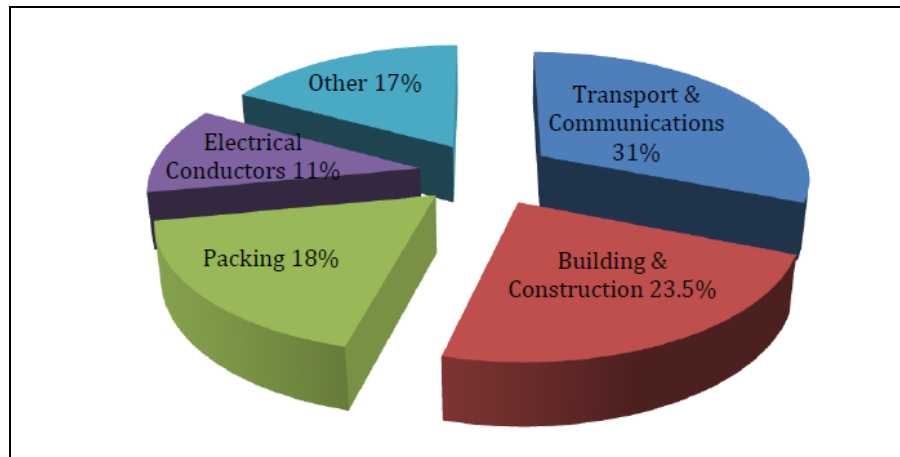


Figure 55: Global Consumption of Aluminium by Use (Gulf Aluminium Council 2009)

EMAL was established in 2007 with the direction to build a world-class aluminium smelter in Al Taweelah, the world's largest single site aluminium smelter. EMAL emerged as a joint venture between Dubai Aluminium Company Limited and Mubadala Development Company. The company began production of aluminium in 2009, boasting a smelter, power station, carbon plant, desalination plant, dock and cast house. EMAL supplies various forms of aluminium products such as alloys, billets and high purity aluminium. Additionally, it supplies rolled products for packaging, lithographic sheets and automotive parts. EMAL has also a liquid metal transfer facility to transfer hot metals directly to downstream industries in the industrial area to reduce the need for re-melting products for extrusion purposes. It has 1200 reduction cells in three pot lines. The EMAL aluminium plant serves the construction sector directly. As indicated by the Department of Economic Development of Abu Dhabi–DED report (2011), UAE's investment in the aluminium industry amounts to \$10.7 billion, which is equivalent to 48% of the Gulf's total investments in this industry. The DED report states that most of the aluminium manufacturing industries produce finished products that serve the building and construction sector along with producing doors, windows and facades.

## 5.2 Case Study Interviews and Observations

In order to confirm the results obtained through the questionnaire, two staff from each population category were interviewed. Two senior engineers/managers and two operations staff

were questioned about the EMS implementation at their facility. To make the verification process even more diverse, one manager and one operation employee were selected from EMAL site; while the second manager and the second operation employee were selected from DUBAL site for the interview. At the beginning of the interviews, the purpose of the study was explained to the participants. They were also shown specific survey results to comment on. Relevant interviewees to the field of study were chosen from both sites. To ease the process of referring to interviewee subjects, the references are established as Manager 1 and Employee 1 for DUBAL site and Manager 2 and Employee 2 for EMAL site. The interviewees requested to remain anonymous for the purpose of maintaining confidentiality due to the sensitivity of the information shared. However, general details about their occupation and years of experience are available in Appendix C. All interviewees are in agreement on the importance of enhancing the environmental performance through EMS implementation. The main questions asked during the interviews are described in Table 8.

**Table 8. Questions asked during the interviews.**

<b>No.</b>	<b>Criteria</b>	<b>Question</b>
1	EMS Experience	What is your facility's experience in EMS implementation?
2	EMS Objectives	Do you have specific targets and objectives for each environmental aspect e.g. air, water, soil and waste? If yes, are these targets and objectives achieved?
3	Environment Training	Do you have any environmental training at your facility? If yes, how do you rate the quality of the environmental training received at your facility?
4	EMS Awareness	The results of the survey have shown that there is lack of awareness about EMS and weak implementation of environmental regulations. Do you agree?
5	External and Internal Factors Affecting EMS	The most influential external factor in EMS implementation is bureaucratic work while the most influential internal factors in EMS implementation is inconsistent top management. Do you agree?
6	Lack of Funding	Is lack of funding a major factor affecting the EMS implementation?



7	NGO's Role	Is there evident role of Environment groups or NGOs at your facility?
8	Environment Performance	How do you see the environmental performance of your facility?

### 5.1.1 Interviews at Site 1

- **Frist Interview (Manager 1)**

Manager 1 was shown the results of the survey at first. He commented that the Environmental Management System (EMS) has been implemented at his facility since they have formalized the ISO 14001 certification process. He also mentioned that most of the EMS audit process is primarily focused on documentation, records keeping and paper work. There have not been much activities or actions taken towards actual activation of EMS at a wider applied scope. In regard to the EMS objectives, Manager 1 claims that the EMS objectives are achieved every year because they always set realistic objectives for every environmental aspect.

There are certain cases, however, where there are accidents due to operational failure, such as power outage, that may cause an increase in the amount of waste generated from the smelting process. In such cases, a huge amount of Spent Pot lining (SPL) waste and hazardous pot line waste is generated and it may exceed the target for reduction of waste.

Manager 1 confirmed that the employees receive high quality environment training that serves their needs and understanding of the operational processes. However, when he was presented with the result of the survey in regard to the lack of awareness about the Environmental Management System (EMS) and weak implementation of regulations, he attributed it to the comprehension-level of the employees. That is, although the environment training is claimed to be of a high level, the employees are unable to absorb the information due to weak educational background and low skill levels. Even though they do increase their technical skill levels with time, adapting to their roles requires time.

Pertaining to the implementation of the regulations, Manager 1 confirmed that there is a regulation gap. He mentioned that there are several environmental compliance requirements at the initiation phase of the industrial plant, for e.g. Environmental Impact Assessment (EIA) Study. However, the regulatory body does little follow-up afterwards and only requests

monitoring reports of the environmental performance at the facility. The regulatory inspections are also modest in their rate and scope. Moreover, there are two conflicting regulatory bodies performing regulatory compliance work and often their requirements are not aligned. He complained that there are no set technical environmental standards for the aluminium industry although it has been operating since the 1970s.

Bureaucratic work, tedious government procedures, complex regulatory and permitting system affect the compliance and the Environmental Management System (EMS) implementation at the facility. When Manager 1 was informed that the external factor most influencing on EMS implementation is bureaucratic work while the internal factor of most influence on EMS implementation is inconsistent top management support, he agreed with the first statement but disagreed with the second. However, Manager 1 claimed that inconsistent top management support may not be the most influential internal factor affecting the EMS implementation. He opines, instead, that budget deficit and cost could be the factors affecting management decisions which lead to their disregard towards EMS implementation. He also reiterated this point when he was asked whether lack of funding is a major factor affecting the EMS implementation. Pertaining to the role of environment groups and NGOs, he confirmed that their role in UAE industries is limited. He mentions, however, that his facility reaches out to these environment groups to participate in their campaigns and to fulfill the corporate social responsibility obligations. In general, Manager 1 was satisfied with the environmental performance at his facility but welcomed continuous improvement.

- **Second Interview (Employee 1)**

Employee 1 from DUBAL site was interviewed as well and was subjected to the same questions. He mentioned that he has only experienced the Environmental Management System (EMS) being implemented at the time of ISO 14001 external audit visits. Employee 1 opined that EMS objectives may be partially achieved due to management direction and cost implications. He also stated that not all environmental aspects have objectives. The environment related training received at his facility is not tailored to the employees need. There is also reluctance from management to provide certified training for staff due to cost; instead, in-house training is delivered by senior employees. Employee 1 also complained that building employee's capacities and providing training with international certification is not a management priority, particularly

at times of financial crisis. Employee's motivation towards work has been decreasing since they do not add up valuable experience to their work profile.

Employee 1 agrees there is lack of awareness about the Environmental Management System (EMS) and lax implementation of regulations. He also commented that the regulatory compliance efforts have not been shared properly with employees and that they do not understand their role and responsibility in this process. Employee 1 also agrees that the external factor of most influence on EMS implementation is bureaucratic work while the internal factor of most influence on EMS implementation is inconsistent top management support. This contrasts with the statement provided by Manager 1, where he did not agree that management directions are inconsistent. Employee 1 held that though lack of funding may affect the EMS implementation, it is not the main factor preventing proper EMS implementation. Mainly, he believes that lack of awareness about EMS and its objectives is the main factor. As for environment groups and NGOs at his facility, he explained that the facility organizes annual clean-up campaigns in cooperation with a specific environment group, providing incentives for employees to participate. However, the environment groups do not participate in the planning and decision-making process at the facility. Employee 1 commented on the environmental performance at the facility by mentioning that it could be improved.

Overall, interviews at the first site revealed more technical details of the environmental performance at the facility. For example, Manager 1 and Employee 1 were aware of the processes and the adverse environmental impact from each process operation. When asked about the types of emissions generated from the smelting process, they were able to identify that greenhouse gases (GHG), hydrogen fluoride (HF), poly aromatic hydrocarbons (PAH) and perfluorocarbons (PFC) are some of the alarming emissions. They pointed out the efficiency of the in-house Fume Treatment Plant (FTP) that recycles hydrogen fluoride for use as aluminium fluoride again in the smelting processes. Additionally, they were able to identify that spent pot lining (SPL) and refractory waste are the most significant hazardous waste generated in the aluminium smelting process. They have confirmed that employees operating in the carbon plant are heavily affected by the petroleum coke, coal, tar and pitch particles and fumes. They mostly suffer from respiratory problems over long periods, despite proper PPE and cartridge masks. The interviews also revealed that power outage incidents have the most catastrophic effect on the aluminium production process as the aluminium smelting process is a continuous process that

entails supply of extensive amount of energy. If power outage incident occurs, then the molten aluminium in the cell will solidify and cause cell, pot line and smelter damage.

### 5.1.2 Interviews at Site 2

- **Third Interview (Manager 2)**

Moving on to interviews conducted at the second site, Manager 2 and Employee 2 were asked similar questions as listed in Table 8. They also viewed and commented on the survey results. Manager 2 was asked about his facility experience in regard to the Environmental Management System (EMS) implementation. He stated that the EMS at his facility has not received ISO 14001 certification yet and that he is trying to get the certification process established at the facility. He stated that he does not have appropriate support from operational department and that the employees are working in silos without proper communication channels between them. He mentioned that project management team and operational team often duplicate tasks and roles. For example, he has requested the emergency preparedness team to maintain certain records pertaining to environmental incidents and protection efforts. Such efforts have not been documented, however, thus unable to be used as credible information for publication or for enhancing company's environmental image.

Manager 2 commented on the Environmental Management System (EMS) objectives that they are not fixed. EMS objectives are amended depending on the economic status of the industry and budget allocated for Environment, Health and Safety (EHS) section. There is a lack of robust targets for each environmental aspect even if industrial best practice is used.

Due to the recent decline in global oil prices, the aluminium industry has been severely affected. As such, environment issues are not a top priority for aluminium companies. There are, however, environment and habitat protection success stories such as keeping a nearby beach protected for nesting turtles every year and minimizing human intervention in such areas. Technical environmental staff and management constantly worry that public, other department employees and external stakeholders may impact the serenity of the site through their visits to the protected beach. Manager 2 also stated that the environment training is adequate. When presented with the survey results showing the lack of the Environmental Management System (EMS) awareness and weak implementation of regulations, he opined that there is a high staff turnover, particularly experienced and skilled ones. This is due to the harsh environment, arid

climate and industry remote location away from the city center. Once employees receive training and gain sufficient experience level, they change jobs to more convenient posts near the city center. Manager 2 believes that there is a regulatory enforcement gap at which the local regulatory authority has strong regulations but weak enforcement. He mentioned that inspections or audits are not regular, occurring every two years if not more. He also stated that local regulatory authority requests quarterly monitoring reports of the environmental performance at the facility but was unsure whether these are regularly reviewed against international best practice.

Manager 2 was then presented with the finding that the external factor most influencing the Environmental Management System (EMS) implementation is bureaucratic work while the internal factor of most influence on EMS implementation is inconsistent top management support. In fact, he was in agreement with both statements. He mentioned that dealing with government entities over the environmental compliance work has not been convenient or easy. Additionally, he confirmed that directions from management in regard to audits findings and EMS vary depending on numerous factors such as the financial status, budget constraints and available resources. Manager 2 held that lack of funding and resources are factors affecting the EMS implementation, but they are not the only barriers. Pertaining to the role of the environment groups and NGOs at the facility, he mentioned that the role is only evident annually at clean up campaigns. These groups are scarcely involved at the facility planning or stakeholders decision-making level. In general, Manager 2 stated that the environmental performance of his facility is below expectation, chiefly due to the poor internal and external communication channels.

- **Fourth Interview (Employee 2)**

In contrast, Employee 2 stated that he did not notice effective Environmental Management System (EMS) implementation. He mentioned that though he has been briefed about the EMS, he had not experienced EMS implementation during his work duties. He is also unaware whether EMS objectives are achieved because he is not involved at the EMS implementation process. Still, he did recall external audits in regard to environmental performance of the facility. At such visits, management would direct staff to fulfill specific requirements beforehand, something that is not a continuous improvement process. Employee 2 also did not know whether there are specific targets for each environmental aspect. In regard to

the quality of the environmental training, Employee 2 mentioned that it was not job specific. He does receive infrequent, generalized training on environmental issues. Moreover, Employee 2 agreed with the results of the survey indicating that there is lack of awareness about EMS and weak implementation of regulations. He mentioned that there are exceedances of emissions which go unreported. There is also a lack of transparency and objective reporting.

When asked about the factors affecting the Environmental Management System (EMS) implementation, Employee 2 mentioned that often it was due to leadership direction. They do receive messages to enhance environmental performance of the facility. However, they receive little or no support in terms of resources. Employee 2 agreed with the results of the survey that the external factor most influencing EMS implementation is bureaucratic work while the internal factor of most influence over EMS implementation is inconsistent top management support. Additionally, he mentioned that lack of funding may be also a factor since environment matters do not take precedence over profit making. It is far more critical to increase profit to cover capital investment and expenditure cost rather than to protect the environment and reduce emissions.

Pertaining to environment groups and Non-Governmental Organizations (NGOs), Employee 2 mentioned that there is an annual clean-up campaign that is in cooperation with an environmental NGO. The company gives incentives for employees' participation. Other than this, he has not seen an active role for the environment groups or NGO's at the facility. Overall, Employee 2 rates the environmental performance of the facility poorly.

In general, interviews conducted at the second site conveyed less technical environmental content. Although the sampling method taken for the interview subjects was random, the level of knowledge and awareness vary significantly between the two sites. For example, though Employee 2 identified that emissions impact the air quality at the facility, he was unable to identify the specific types of emissions. That said, both sites indicated that power outage incidents have had catastrophic impact on pot operations.

In summary, four extensive interviews were performed on two different aluminium industrial sites. It was observed that Site 1 had stronger Environmental Management System (EMS) implementation experience and conversed employees whereas Site 2 had less EMS evident experience. This was reflected by the staff awareness and experience level with EMS. Site 1 had

been operating for more than thirty-seven years while Site 2 had been operating for only seven years. Therefore, it is perhaps unsurprising that Site 1 yielded superior EMS implementation.

### 5.3 Site Visit to Operations and Processing Units

A technical site visit to the aluminium production plants in UAE clarified the aluminium processing stages from raw materials to production of finished products. A detailed technical description of how aluminium was produced in pot lines was explained through the plant site visit. The main raw materials required for aluminium production are alumina ( $\text{Al}_2\text{O}_3$ ), calcinated petroleum coke, liquid coal tar pitch and aluminium fluoride ( $\text{AlF}_3$ ). The molten aluminium is produced by electrolytic reduction process of alumina in a liquid bath of cryolite using the Hall-Heroult process. The carbon anodes in the pot lines are pre-baked and comprise of petroleum coke and coal tar pitch mixture. During electrolysis, the alumina content in the liquid bath diminishes, causing the release of fluoride gas in the pot line. This is known as anode effect and it can be corrected by periodically feeding alumina into the hopper to maintain the electrolytic reduction process. The quality of the production process increases if there are less anode effects during operations. After the production of the molten aluminium, it is then collected and sent to a cast-house using specialized crucibles. In the cast-house, the aluminium gets shaped into different forms such as ingots, slabs, or rods and other alloy additives can be added such as silicon or copper. The two sites, DUBAL and EMAL, have the same applied technology for the production of aluminium. In fact, there are several cell reduction technologies developed in-house to enhance current efficiency, energy consumption, and environmental performance, which eventually augment productivity. These technologies are DX, DX+, DX+ Ultra and D18+ with each technology having its specific features and characteristics. Refer to Fig. 56 for evolution timeline of aluminium smelting technology. For example, DX+ offers reduced environmental impact through less fossil fuel consumption and less carbon anodes consumption, thereby making the production more sustainable. This particular technology was selected by ALBA, regional Bahrain smelter, to be implemented in one of its production pot lines.

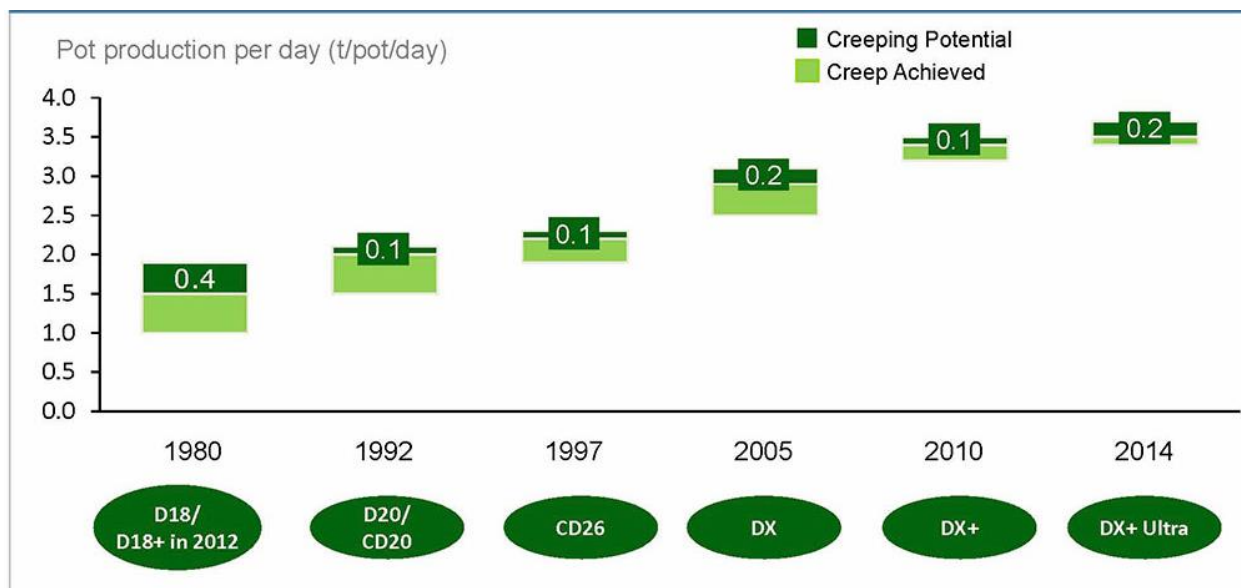


Figure 56: Technology Development in DUBAL.

Furthermore, the two sites in Jebel Ali and Al Taweelah had similar smelting technologies. Al Taweelah site is located in a remote area away from urbanization whereas the Jebel Ali site, is being encroached by urban growth thereby necessitating that regulatory compliance and adherence to emission limits is strictly followed. The Jebel Ali site had more advanced offices and facilities while Al Taweelah site had more temporary offices and on-going construction and expansion activities.

Pertaining to the environmental impact of the aluminium smelting process, the site tour of the two plants helped establish the scope of the environmental impact along with the types of process operations mitigation measures to control these impacts. Consumption of raw materials, combustion of fossil fuel, emissions to atmosphere, generation of waste and discharge of effluent are the most evident environmental impacts of aluminium production. Moreover, being an extremely energy intensive industry, there remains pressure on providing continuous energy with acceptable price, especially in the Middle East. Optimizing process operations was one technique to enhance energy efficiency and recovery during the aluminium smelting process. For example, in 2012, the Jebel Ali site achieved a 5.5% energy reduction in electrolysis process compared to 1990 (DUBAL 2012). By discussing the other major environmental impacts of the aluminium smelting process, technical site engineers have highlighted the nature of the generated SPL waste as it is classified as hazardous waste. The previous practice in dealing with SPL was landfilling. However, UAE aluminium smelter based in Jebel Ali has proposed using SPL as alternative fuel



and raw material for the cement industry. They have conducted an Environmental Impact Assessment (EIA) study to further investigate hazards associated with introducing this new practice. Formal agreements have been signed with local cement industries in 2009 where the generated SPL from the smelter process is taken for recycling at local cement industries sites.

Further research has been conducted to investigate the SPL usage as raw materials in the concrete mix, with experiments showing improvement in the compressive strength of the concrete sample (Mbadike and Osadere 2014). However, scholars have safety and environmental concerns regarding the SPL usage in concrete due to its hazardous nature during and after the concrete manufacturing and application process. For example, adding SPL in the concrete may increase the CO<sub>2</sub> emissions during mixing. Additionally, it may produce toxic gases at the concrete disposal stage. Therefore, scholars are advocating for a healthy and environmentally sound production process of aluminium that enables the production of healthy SPL waste for use in concrete applications (Yu et al. 2015).

There are also other types of wastes such as aluminium dross, generated when aluminium oxides form during the casting process. Dross is also formed when pouring of molten aluminium into the cast, furnace and mixing operations. Usually, this waste is recycled in-house at the smelter using coolers and metal recovery press. The recovered metal is recycled and further dross formation is limited by minimizing metal surface contact with air. Jebel Ali Aluminium smelter has electromagnetic stirrer to allow circulating of metal inside the furnace without contacting with air. It is reported that 4% of decrease in dross generation is achieved through this stirrer concurrently decreasing the consumption of natural gas.

## **5.4 Critical Review of the Environmental Management Tools**

There are several environmental management tools employed at the aluminium industry in the UAE. Although their visibility and strength require further investigation, the research intends to shed some light on their usage through the case study.

- **Measurement and Improvement**

According to Burritt et al. (2002), it is essential to measure the environmental performance at the facility because one can only manage and control what is measured and

monitored. Measurement of emissions data and environmental performance data e.g. amount of generated waste, PFC and CO<sub>2</sub> emissions, amount of brine discharge back to the sea were carried out at the site periodically. The facilities report such data to the concerned government authorities, along with international lenders bodies such as World Bank. The loans are governed by attaining a certain level of environmental standards, including registering for an ISO 14001 Environmental Management System (EMS) certification. It has been observed that by following a rigorous cycle of data analysis, improvement targets are being set and are continuously being aspired for. Both the Jebel Ali and Al Taweelah sites have used measurement and improvement as environmental performance and management tools.

- **Pollution Prevention and Resource Conservation**

The second environmental management tool is pollution prevention and resource conservation, where the latter being driven mainly by profit. During the site tour, it was observed that there are pollution prevention technologies installed at the plant such as the Fume Treatment Plant (FTP). As the name suggests, the unit is concerned with treatment of emissions and fumes generated from the manufacturing processes. It contains sulfur dioxide scrubber and hydrogen fluoride recycling unit. Additionally, it captures PFC and its related greenhouse gases.

Resource conservation was also observed during the site visit in the form of minimization of the consumption of raw materials, such as alumina, and sweeping the remains from the floor. The remains were placed into cell reduction unit. Coke tar pitch was also being baked with minimum resources whilst keeping the quality of the materials intact. According to Schaltegger and Wagner (2006), minimizing resources is a practice that always benefits the industry through exhibition of lean management and six sigma approaches in the industry.

- **Environmental Gap Analysis**

The third environmental management tool employed was environmental gap analysis. This tool details the difference between the current Environmental Management System (EMS) status of the company and what needs to be there to achieve an efficient EMS. Crucially, the survey conducted for this research has pointed out the gaps in the environmental management system. Environmental gap analysis is a great method to understand the current situation and set mitigation measures to overcome the shortcomings of the system (Schaltegger et al. 2003). The

environmental gap analysis tool was also being utilized in the aluminium industry through initial environmental review, external and internal audits.

The main check areas of the environmental gap analysis approach are environment policy and aspects, rules, regulations and legal framework, objectives and target setting, organizational structure, defining roles and responsibilities, environmental management programs, environmental training and capacity building, Environmental Management System (EMS) documentation and reporting, emergency preparedness and response, communication, monitoring and measurement, audits, nonconformance, correction and preventive actions, and finally management review.

Retrospect Environmental Management System (EMS) assessment analysis revealed that in general there were gaps at the legal framework governing the aluminium industry. Furthermore, roles, responsibilities and environmental management programs were not fully established. The environment training at the facilities were not specific to the role and was not abreast with the latest technological advancement. There was also no clear direction whether there would be shift in energy sources used to power the manufacturing processes or provide linkage to power grids that are more sustainable. Monitoring activities were only covering the status check for basic environmental aspects. KPIs to measure environmental performance need to be provided to public. According to Orr (2004), simply educating the public about the emission levels and the environmental performances of industries can raise awareness towards shaping the future direction. It was also observed that the public role in the process is limited due to various cultural and governance dimensions. There is, however, a need for EMS advancement from being just a tool on paper to being a fully integrated tool within the industry. There were also good record-keeping and follow-up actions implemented, even if some remained on hold due to the financial deficit that the industrial sector has been experiencing since 2015 (Pagiola and Platais 2016).

- **Best Environmental Management Practice**

The fourth environmental management tool that was employed at the aluminium smelter site in Jebel Ali is the best environmental management practice. While on-site, several best management practices were observed in areas related to materials storage, loading and unloading operations, emergency preparedness and response, and resource conservation. Other

environmental management tools were also observed. The environmental performance was measured mainly through reporting to government authorities, ISO, international certification bodies, audits, and to internal compliance checks.

- **Environmental Benchmarking**

The final environmental management tool is environmental benchmarking. While European countries have shown advanced regulatory and compliance systems, a fully matured environmental legal system is not yet existing in UAE, particularly when pertaining to aluminium industry. Dentoni et al. (2014) have explored the environmental sustainability of the alumina industry in European countries and have concluded that further strict modifications will be imposed on the processes to reduce the harmful environmental impacts, such as bauxite residue disposal and landfilling. The environmental benchmarking tool is still not visible in UAE's aluminium industry due to cheap and subsidized energy sources, availability of land for disposal of waste compared to in the same countries, limitations on the use of alternative energy sources such as hydro-power, wind power and geothermal due to location restraints and technological barriers, and fast-pace development that requires immediate production without long-term strategic planning. Morrow and Rondinelli (2002) have acquired that latter technique to reduce the environmental impacts of the industry by utilizing the best location for the aluminium plant where energy optimization, environment compliance and operational excellence are achieved.

Pertaining to the environmental benchmarking tool, the case study highlights how the industry holds insufficient information on use of life-cycle analysis (LCA) in the aluminium industry. There was no observed data on LCA usage and its connection to the down-stream end-products. Recycling was only limited to the activities and processes within the industrial site and was not extended into the actual application of aluminium in construction projects. There was no local data available that supported recycling efforts to showcase the complete aluminium circular economy and the benefits obtained from investing in such activities (Darnall & Edwards 2006). As such, the need for a study, that links the manufacturing and upstream production with downstream and construction applications, is glaring.

It is therefore concluded that the most evident and applied environmental management tools used at UAE aluminium plants are measurement and improvement, pollution prevention

and resource conservation, and environmental best practice. However, the other tools, Environmental Life Cycle Assessment (LCA), environmental benchmarking and environmental gap analysis were less employed.

Through research and further interviews with industry professionals, the following rules, regulations and rating systems have been referenced:

1. Regulatory environmental compliance and permitting is managed by Environment Agency, Abu Dhabi (EAD). This is a mandatory system whereby all industries and construction projects are required to submit the scope of work and environmental permit application to determine the type of required environmental studies. Environmental studies vary due to the complexity and impact of the proposed activity. For example, for an aluminium plant to be operated, an EIA should be conducted to assess and quantify the environmental impacts. Moreover, regular environmental monitoring reports should be submitted to ensure compliance is achieved. For construction projects, the typical environmental study requested is the Construction Environmental Management Plan (CEMP). This study allows the contractor to focus on the environmental and sustainability performance during the construction process. However, there is lack of enforcement and monitoring due to the rapid rate of construction projects in Abu Dhabi (Environment Agency – Abu Dhabi 2015).
2. Estidama Pearl Rating System managed by Abu Dhabi Urban Planning Council (ADUPC). This is a building rating system of five pearl levels, where the achievement of one pearl is mandatory for all construction projects within the Emirate. Two pearls sustainable rating should be achieved by government investment projects. Similar to LEED and BREAM (Lee and Burnett 2008), this rating system offers cultural dimensions to be implemented into the typical sustainability pillars, economic, environmental and social. The Estidama PRS guidelines tackles all aspects of sustainability on villas, buildings and communities, from management of waste, natural system assessment, water and electricity usage, innovative practices and stewardship building materials. The discussion on usage and recycling of aluminium can also take place. Although the rating system is flexible, it has not placed a huge emphasis on the compliance and enforcement as most of the projects fall within one pearl, where fewer credits are mandatory (Urban Planning Council 2007).

It is therefore imperative to understand the environmental and sustainability legal framework within the UAE and existing systems so that the proposed framework build on existing efforts. Building on existing knowledge will facilitate the framework introduction process rather than re-inventing the wheel and proposing exhaustive sustainability framework and environmental legal structure within the UAE.

## **5.5 Case Study Findings and Analysis**

The case study confirmed some of the findings highlighted by the questionnaire. It was evident that the Environmental Management System (EMS) experience at both Site 1 and Site 2 vary due to site operational age, where site 1 is older with more experienced staff than site 2.

The key finding of the case study is manifested in a variance in understanding EMS knowledge between the managers and the operational staff. For example, in regard to awareness programs and training, managers and employees' perspectives were dissimilar due their expectation levels and this explains why many respondents in the survey believe there is a major defect in the environmental communication. As consequence, the knowledge level of operational staff is highly associated with the management visibility and leadership towards the EMS. This can be sensed in the case study where staff environmental awareness and level of technical knowledge at Site 1 is higher than Site 2.

The case study in both Site 1 and 2 confirmed that managers and operational staff are two different populations as concluded in the questionnaire. Managers and operational staff perspectives towards EMS is different due to various reasons such as lack of communication, level of staff awareness, operational staff education level, and leadership involvement. During the site visit, operational supervisors in Site 2 were less visible on site while operational staff were carrying out their duties. Therefore, lack of supervision, hands-on training and guidance as concluded in both the questionnaire and interviews was demonstrated in the site visit.

The case study concluded that the sound environmental performance practices at Site 1 are well established when compared to Site 2. The interviews in Site 1 demonstrated in-depth knowledge about the environmental performance compared to Site 2. Through the site visit, further observations were carried out on the advancement of Site 1 and the ability to export technology to other smelters. The utilization of the environmental management tools was also

examined through the case study and it was determined that even though measurement and improvement, pollution prevention and resource conservation were practiced on-site, aluminium life cycle assessment, and environmental benchmarking fell short in application. At best, environmental gap analysis and environmental best practice were followed on a relatively smaller scale.

As such, the findings of the case study, site interviews and questionnaire confirmed a substantial need for a holistic framework encompassing the essential elements of an efficient EMS. A recipe for successful implementation of the EMS at UAE aluminium industry is much needed to raise awareness and bridge the gaps between the management and operational staff and minimize their differences. In the next chapter, description of the proposed framework and its development process will further detail the purpose and need of this framework.

## Chapter 6: Development of a Framework for Efficient Implementation of the Environmental Management System

### 2.1 Framework Structure and Function

To come up with the corner stones of the proposed framework, the list of statistically significant factors presented in Table 7 was reviewed. The significant factors were mapped to the main gaps in the implementation of the EMS as shown in Fig.57. These gaps were further mapped into three main categories, organizational factors, systemic factors and human factors as explained by the EMS diamond Fig. 59.

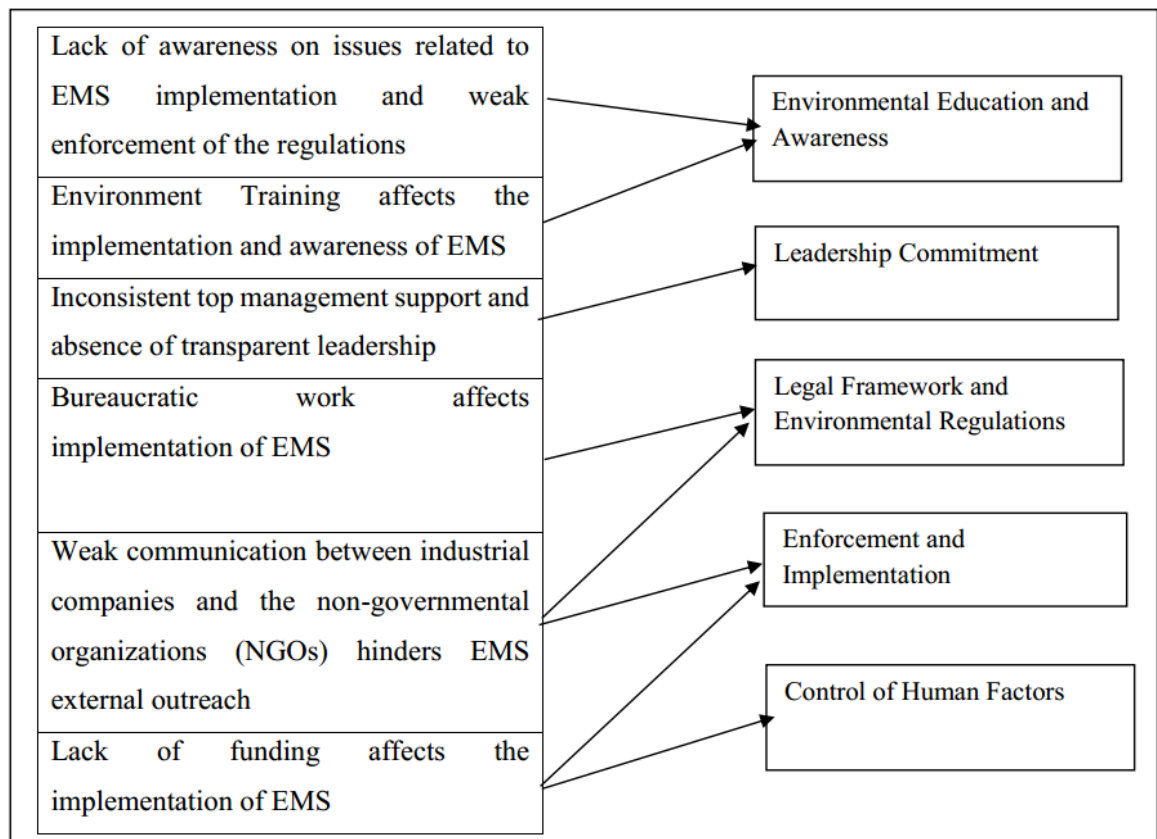


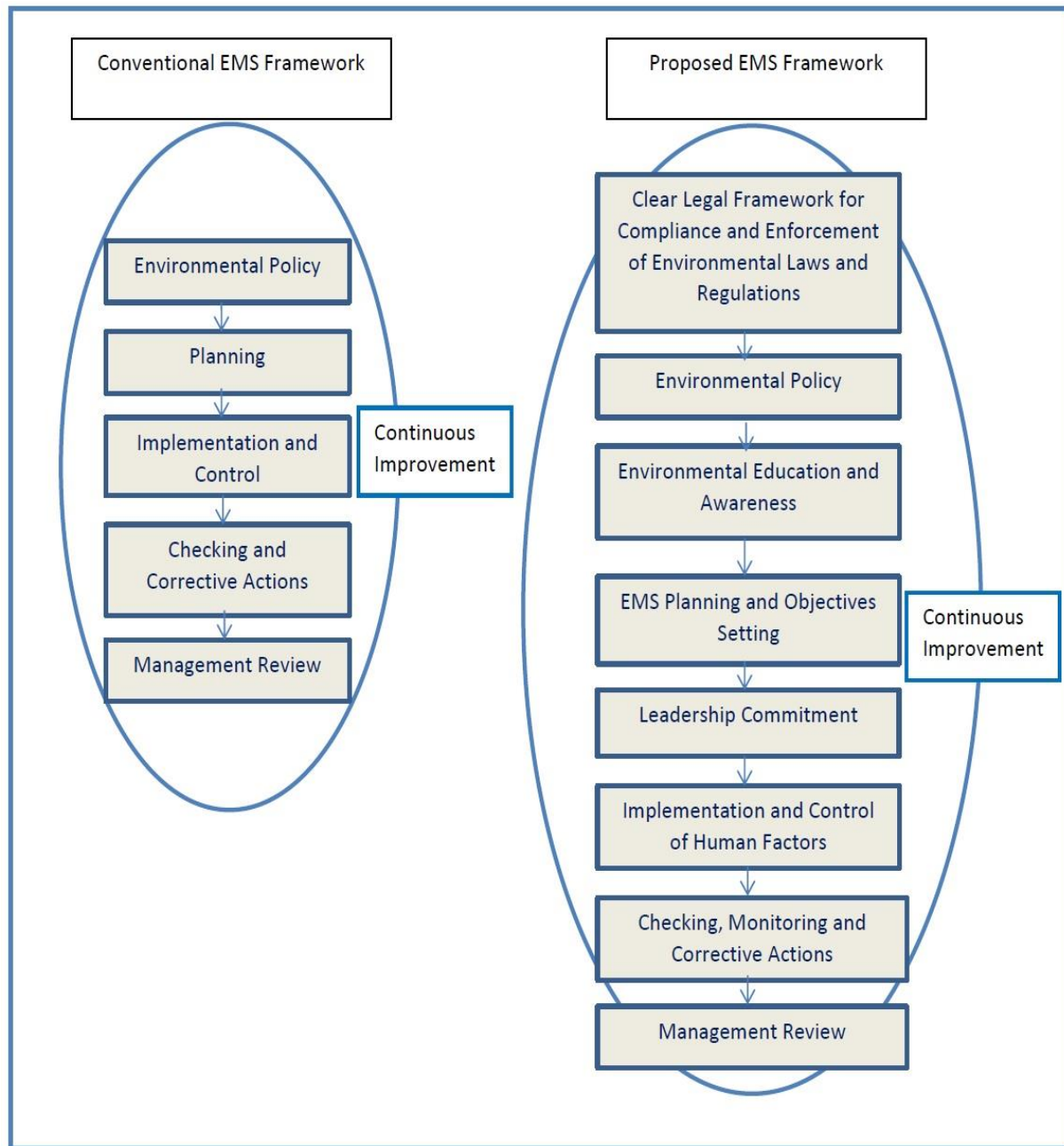
Figure 57: Mapping Statistically Significant Factors to the Main Gaps in the implementation of the EMS

In addition, the proposed conceptual EMS framework was superimposed on the ISO 14001 EMS conventional framework in Fig. 58 to understand the differences in the steps and the complexity of the layered proposed framework. For example, the conventional ISO 14001 EMS framework has a legal framework that is impeded within the planning step while the proposed



EMS framework has a legal framework for compliance and enforcement as an independent stand-alone step. This reflects how important is the legal framework in the EMS model. The proposed conceptual model has some similarities to Feng's hypothesis and model (Feng et al. 2014). The model confirms that the interaction between the Environmental Management System (EMS) and the following aspects has a positive impact on firm performance: commitment to learning, shared vision, open-mindedness, and knowledge-sharing. The proposed framework poses similar aspects to Feng's model such as education and learning, knowledge-sharing and shared vision. It is evident that the model discusses learning, leadership commitments through vision, control of human factors as opposed to open-mindedness and knowledge-sharing through environmental awareness and continuous improvement. This conceptual framework draws on the missing aspects of the conventional EMS system and stresses the importance of having a legal framework for EMS compliance and enforcement, commitment from leadership, education and awareness, and human factors management. Fig. 58 explains the difference between the conventional EMS framework and the proposed conceptual EMS framework. Additionally, it explains when to engage the added dimensions in the EMS process, such as legal framework and education.

Elements such as clear local legal framework should be established prior to the Environmental Management System (EMS) cycle initiation. In fact, it forms the basis of all industry regulations. If the specific industry is lacking environmental specific regulations, usually the mother company's regulations or international best practice regulations are followed. Awareness is of vital importance that comes directly from setting a policy for the industry. After the EMS objectives are finalized, leadership should commit to these objectives. The element of control of human factors is diverse in nature and is continuously monitored. Evidently, a new perspective is essential to further apply the Environmental Management System (EMS) in the aluminium operational processes.



**Figure 58: Conceptual Efficient EMS Framework.**

To understand the steps and the components of the framework, four main questions should be answered:

- What is the framework for?
- How should it be implemented?
- When should it be implemented?

- What are the roles of the industry and the government in implementation of this framework?

These questions will be further answered through the analysis of the proposed framework as they constitute the main compartments of the framework.

The proposed framework has unique features in many senses. It basically offers incorporation of other human, system and organizational factors in the system's building blocks. Through the conducted questionnaire, case study and interviews, the framework of the efficient the Environmental Management System (EMS) has been developed as shown in Fig. 59 of the EMS diamond. This framework will entail the EMS to be far more than just a paper based tool or a record-keeping exercise. To measure compliance with this enhanced EMS system, a different method of validation should be used. The verifier should spend considerable time at the plant working with all human subjects and assessing the strength of the system through day-to-day operations, site observations and performance indicators.

The Environmental Management System (EMS) diamond in Fig. 59 is structured upon the basic requirements of the efficient EMS i.e. the actual building blocks of EMS. These 5 essential elements belong to 3 main descriptive groups, which are human, systemic and organizational factors. It is named as the EMS diamond as a reference to its precious nature in which its corners are the building blocks of the EMS framework. The requirements include but are not limited to human, system and organizational factors. Human factors include management of workers, welfare, enforcement and implementation. Organizational factors include education, awareness and leadership commitment. Finally, system factors include having a legal framework and environmental regulations to govern the activities of this sector. The interactions and the interrelations between human, systemic and organizational factors have resulted in the generation of an EMS diamond. As such, Fig. 59 is dedicated to answering the question, what is the framework in which it focuses on three vital areas: organizational, systemic and human factors.

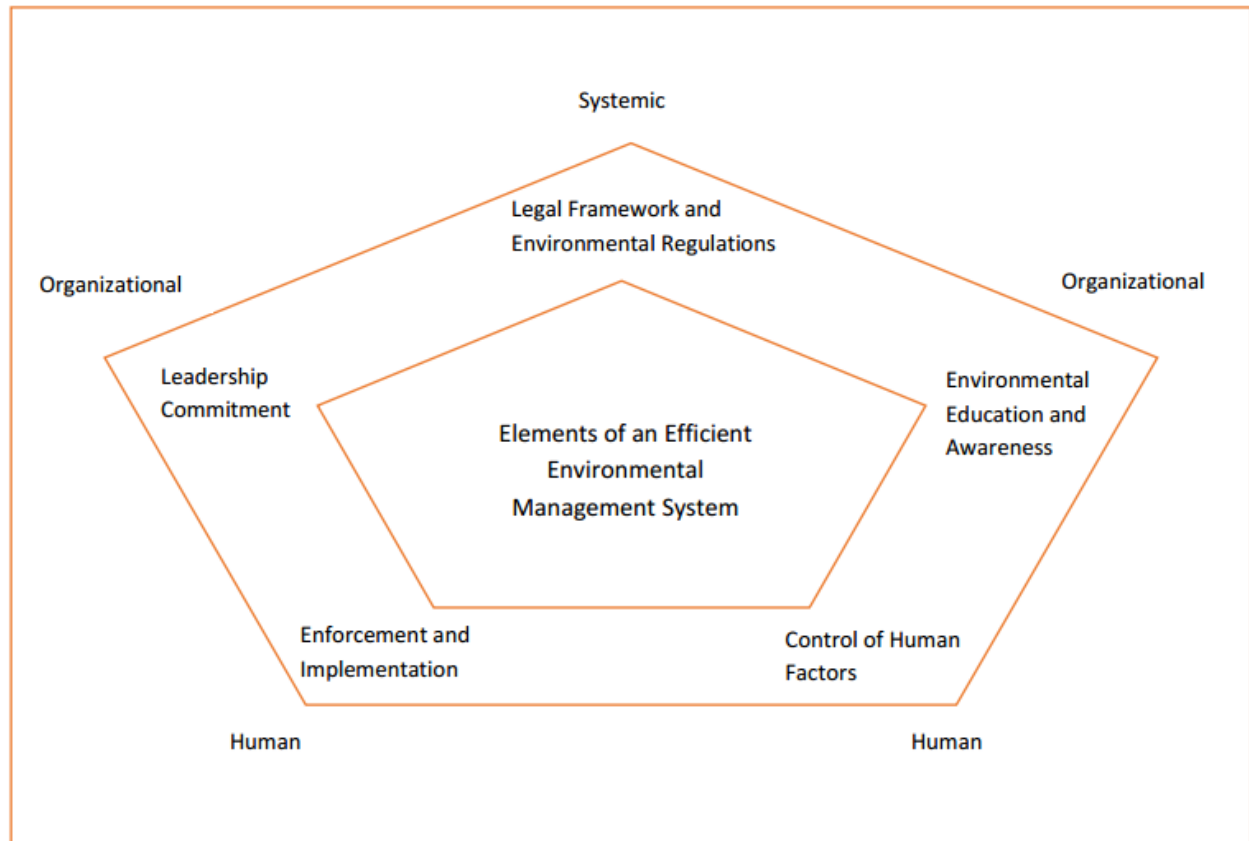


Figure 59: EMS Diamond.

To apply the foundation of the efficient Environmental Management System (EMS), further steps such as, scope of work or implementation methodology is needed. Fig. 60 below details the steps of an efficient EMS system. Fig. 60 explains the importance, roles and mechanism between the attributes of organizational factors, systemic factors and human factors in implementing EMS in the workplace. Fig. 60 further details the pillars and the elements of the efficient EMS process. Each pillar of the EMS proposed framework will be further discussed to establish its important role in this framework.

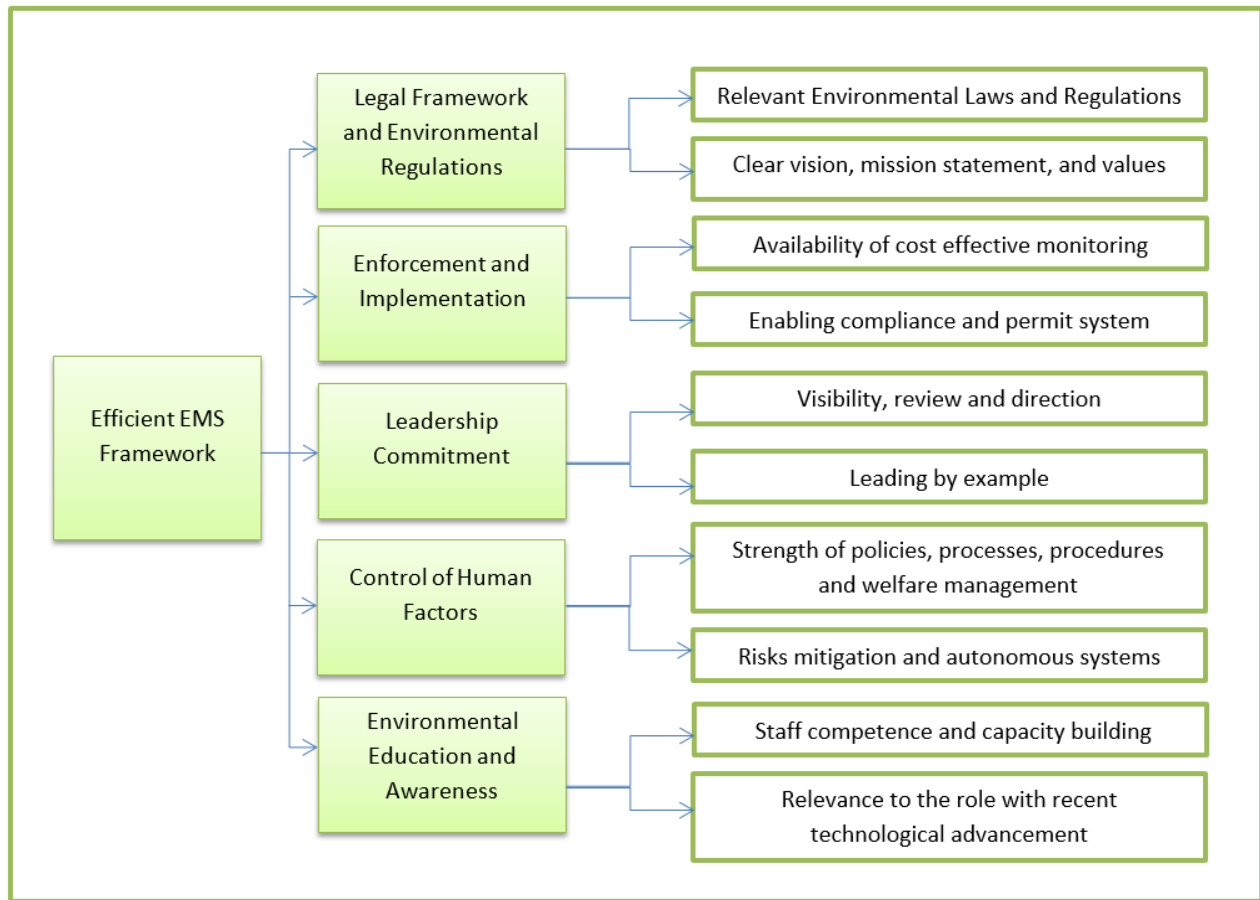


Figure 60: Elements of Efficient EMS Framework.

## 2.2 Legal Framework and Environmental Regulation

The most essential corner of the Environmental Management System (EMS) diamond is the legal framework and environmental regulations. In order to fulfill the requirements of this corner, two main inputs are required: relevant environmental regulations set in place, and a clear mission statement and values for the organization. Relevant environmental laws and regulations should be set from an authorized legal agency in the country. In the UAE, federal relevant laws followed by executive orders should be established. The Federal Environment Law No. 24 of 1999 for the protection of the environment and its relevant executive orders details how the environmental law is implemented in regard to industrial activities. However, it has been observed that not all environmental parameters relevant to the aluminium industry are addressed in the law and its executive orders. For example, hydrogen fluoride emissions from the smelter processes have no specific emission limits. Instead, the industry employs best international

practice and World Health Organizations (WHO) limits as a substitute for the lack of local emission limits.

Law No. 24 of 1999 is administered by the Ministry of Climate Change and Environment MoCCE (formally known as the Ministry of Environment and Water - MoEW). However, every local emirate has its own authority. In Abu Dhabi, the Environment Agency - Abu Dhabi (EAD) is the concerned competent government agency for administering Law No. 24 and its compliance. EAD has established regulatory guidance for general industries but is yet to establish specific aluminium industry regulations. A holistic review of the industry's relevant environmental regulations is required to fully comprehend the limitations of the local legal system. According to Fernández et al. (2010), to have an effective EMS system in the workplace, it is vital to enforce a robust legal framework and provide a comprehensive applied legal system for all organization employees. For example, this legal framework can help the organization arrange their business procedures with all laws and regulations of the government sectors, stakeholders and shareholders who are involved in the operation. Additionally, this industry relevant legal framework, laws and regulations can help in protecting natural resources, regulating the industry and set specific standards to the context of the operations in UAE. Bartley (2007) mentions that it is essential for the regulatory system to follow the cultural and political requirements in the operating countries; especially regular technical and industrial requirements. This explains the convenience provided by local regulations rather than the mother company regulations, where the latter are often stricter and specific to the industry nature.

The second input to the requirements is clear vision, mission statements and values. Setting up these essential communication tools will help in fixing communication gaps and aligning high level goals of the company. Mirvis et al. (2010) identified the power message that vision, mission and values of the organization have on setting the focus and the direction of the company. The authors examined three major companies, General Electric, Unilever and IBM, approach to sustainability through embedded messages in the vision, mission and values. The vision provides the strategic direction of the company and defines its future. It is therefore essential to establish a clear vision, mission and values for the organization while keeping in mind to include relevant environmental management reference in them. Although the environment, health and safety policy usually details further focus on the environment, health and safety direction of the company; reference to the environment aspects of the industry should

still be reflected in the vision, mission and values of the organization (Eltayeb et al. 2011). Moreover, the vision, mission and values of the company are important also in explaining the company's purpose, strategy and future direction for various stakeholders such as the employees, the corporate management and the public. The vision provides summary on why the company is operating, the mission provides details on what is the company doing, while the values explain who the employees and staff are. These three important messages should also be reviewed regularly in case a change management has occurred which requires further amendments in the strategic direction.

To sum up, a clear legal framework with relevant environmental laws and regulations is important in regulating the industry. This legal framework needs regular evaluation to ensure it is effective in solving the industry specific dilemmas and technical constraints. Moreover, a tailored vision, mission and values should be established for the organization. The vision, mission and values should embed environment agenda into the main company's industry stream to be used as a steering mechanism for further guiding the strategic direction of the company.

### **2.3 Enforcement and Implementation**

One of the major gaps of all regulatory and compliance systems are enforcement and implementation. Availability of man power, equipment, management direction, enforced regulations and compliance monitoring are essential for implementing the requirements of a regulatory system. In many cases, the legal regulatory framework is well-established. The weakness, however, lies in the enforcement and implementation methodology.

There are mainly two outputs to empower enforcement and implementation of the regulatory system: availability of cost effective monitoring and enabled compliance and permit system. According to Amann et al., (2011), cost effective monitoring involves discovering clever organizational solutions to focus resources and target compliance. An example would be random and regular inspection visits to different facilities to inspect compliance with environmental regulations. This way all facilities can expect a visit ensuring that their readiness for inspection visits are continuous. In case non-compliance is observed, a follow-up visit can be scheduled to ensure that all non-compliance issues are addressed. Another example of cost effective monitoring is the adoption of Best Available Technologies Not Entailing Excessive Cost (BATNEEC). The aluminium industry could adopt technologies that reduce energy use, waste and greenhouse gas emissions. The Environment Protection Agency (EPA) in Ireland has a set of

guidance notes for BATNEEC used in several industries. In the 2008 issue of the guidance note, the Irish EPA tackled the sector of the general inorganic chemicals and the production of alumina. The guidance note describes the manufacturing processes, the likely environmental impacts and associated risk to the environment. Additionally, the guidance note provides techniques for the prevention and minimization of resource consumption, energy use, waste water treatment and emissions. For example, dust treatment techniques include but are not limited to separators, cyclones, wet dust scrubbers, fabric filters and electrostatic precipitators while combustion gas treatment include dry alkali injection, wet lime injection and selective catalytic and non-catalytic reduction techniques (Ireland Environmental Protection Agency 2008)

Research and development on the best available technologies relevant to aluminium manufacturing supply chain, such as scrubber systems, air pollutants filters, and HF monitors, can further empower cost effective monitoring techniques. It is important to note that other cost-effective monitoring methods include human resource management and risk management. For instance, placing the experienced employees in specific posts that allow them to supervise the workflow or managing risks related to failures through eliminating risks or accepting certain threshold of errors (Malluche 2002).

The second input is the enabled compliance and permit system. It is insufficient to have laws, regulations and legal framework for the industry to operate. Instead, it is vital that the latter are further supported by enabled compliance and permit system to monitor environment performance and set regulatory fines. A robust permit system is required to ensure regulations are followed and permits are obtained before commencement of activities. Through interviews with industry professionals, a foreign company expert in the field of oil cracking catalysts wished to start a business venture in Abu Dhabi. However, by studying their permit applications and relevant process operations, it was discovered that a harmful, ammonia-based byproduct would be released into the sea, untreated. The company intended to release the byproduct to the sea without treatment to save costs, assuming that operating their business in a third world country would ensure ineffectual environmental standards and regulations. However, they were opposed by a thorough regulatory compliance system that mandated treatment of their byproduct to a certain acceptable standard before release. Their competitor refused to comply and opened business in neighboring country, noting that all regional countries use the same Arabian



Gulf waters. It is concluded that a regional compliance and enforcement programs should be established to control such industries breach in laws and regulations as the final receptor of pollution is the same water body. When it comes to aluminium industry, a streamlined compliance and permit system is important so as to guarantee that the industry measures its output and emissions.

Enabling compliance and permit system can be best administered through phases with the help of enforcement and media campaigns. According to Nicholson and Toole (2004), the stronger the enforcement measures, the more compliant companies are to laws and regulations. The compliance and permit system can be enabled through monetary fines, assessment and inspections. Monetary fines act as an incentive to reduce emissions and environmental incidents. According to Environment Agency Abu Dhabi (EAD), the gap in the environment management implementation lies in the follow-up after the Environmental Impact Assessment (EIA) study is conducted, approved and a permit is issued. The government body does not have sufficient resources to cover the tasks and obligations following the issuance of permit and fulfillment of requested EIA studies and there is no post commissioning follow up by regulators in the UAE. Therefore, companies relax towards the commitments stated in the EIAs and the issued permit conditions. Marshall (2004) has highlighted how the industry can benefit from the follow-up process by adopting proactive approach through a combination of the key drivers for establishing environmental compliance, such as environmental ethics, continual improvement within ISO14001 environmental management system and corporate governance programs.

In conclusion, enforcement and implementation can be supported by availability of cost effective monitoring and enabled compliance and permit system. This alone may not suffice but will aid in focusing resources to enforce regulations more effectively. Other tools that can be used to maintain enforcement efforts include risk assessment of certain industries and history of violations obtained in specific companies.

## **2.4 Leadership Commitment**

The new revision of the ISO 14001 has identified leadership commitment as an independent clause to highlight and emphasize the role that leadership plays in the Environmental Management System (EMS). The standard also eliminated the need to have environmental management representative but ensured that this role is embedded in the organizational structure of the facility (Testa 2014).

The main pillars of leadership commitment requirements are visibility, review and providing direction, along with leading by example. In many cases, leadership and top management delegate their responsibilities to middle management. It is important to remember, however, that they are still accountable under the environment management framework for the fulfillment of their role. Primarily, leadership are tasked with ensuring availability of environment policy and objectives that are compatible with the strategic direction of the company, the robust and complete integration of the Environmental Management System (EMS) requirements into the business processes, ensuring availability of resources for successful EMS experience, and providing support and guidance all throughout the EMS implementation cycle. These roles ensure the visibility of the management and increase effectiveness of the work process. They can inspire employees to achieve their environmental objectives, especially when leadership and top management provide sufficient review and set direction for environmental improvement within the facility.

Enz and Grover (1992) state the importance of top management visibility in the sense that companies are merely a reflection of their top management beliefs, values, decisions and directions. Visibility acts as a symbol of active top management participation in the processes, management and care for the organization. There are benefits to top management social engagement with their staff in terms of motivation as they rely on their employees for successful implementation of tasks and objectives accomplishments. Top management has an essential role in conveying the company's values throughout the organization and motivating the internal culture of the working groups. Additionally, end of year performance review meetings depends highly upon management's presence to provide strategic direction and planning towards the organization's focus areas, challenges and objectives for the next year. Leadership's commitment for continual improvement is of utmost importance in the management review process and in setting the framework for the EMS (Linnenluecke and Griffiths 2010).

Leading by example is another important aspect that top management and leadership can exercise to enhance environmental performance at the facility. When employees perceive that their top management practice sound environmental management actions and encourage environmental commitments, they will follow their leadership throughout their daily activities. The company can aspire to become a model of organizational excellence via leading by example, starting from top management to least experienced employees. In fact, leading by example can

help achieve compliance targets and maintain high environmental performance levels whilst still preserving the environment. Leadership can easily use this tool to convey the practice required for employees to follow.

In regard to environmental management at aluminium industry, this can be applicable by means of minor actions such as good housekeeping practices, to major actions such as installing the best technologies so as to reduce emissions and treat fumes during operations. When management recycle waste paper, this would encourage employees to follow their example and recycle waste. To create an environment focused organization's culture, management should strive to lead by example, attend environment related meetings and trainings, and participate in environment events. Management should also nourish an environment-based culture that shares similar beliefs, attitude, practices and behavior (Sammalisto & Brorson 2008). In the aluminium industry, it was noted through interviews that discrepancies arose in management's direction towards environment targets during audit process, whether external or internal. For instance, some of the spent pot lining waste that could be diverted to cement industry was stored in company's storage rather than being utilized effectively. Management committed verbally to recycling the waste but was not acting upon the commitment. The key message to industry here is for management to act upon the commitment made under the environmental management system (Dao et al. 2011).

In conclusion, leadership commitment can be achieved through visibility, review and providing direction, along with leading by example. These elements constitute strong leadership commitment to the vision, mission and objectives of the organization. Leadership commitment influences the Environmental Management System (EMS) efficiency directly. The more committed the leadership is to their environmental objectives, the more efficient and transparent the environmental management system implementation processes are.

## **2.5 Control of Human Factors**

Scholars consider the control of human factors as the most important pillar of the efficient environmental management system (EMS) (Iraldo et al. 2009). Human factors are mainly any internal or external influences that affect human behavior. Pertaining to EMS, human factors include reduction of environmental risks to an acceptable level (ALARP), i.e. reduction of human errors that causes environmental accidents. The two main elements that contribute in the control of human factors function are:

- The strength of policies, processes, procedures and welfare management
- Risk mitigation and autonomous systems.

Strong policies, procedures and clear processes assist the workers in understanding the concept of EMS with relevance to their line of work. Policies and procedures should be set up to control human factors for elements such as welfare and training. By providing the operational staff with adequate technical support to enhance their skills and an appropriate environment to live and work in, human factors can be better managed. Welfare can be administered in forms of programs, services and workers dedicated to enhancing staff wellbeing and happiness. Strategic placement of resources is though required to manage social welfare in context relevant to environmentalism and related regulations (Maxwell et al. 2000). The EMS, along with other quality, health and safety systems, assures the integration of systems into the work processes and highlights their importance in all performed tasks. Having technical policies and procedures for implementing EMS in the processes will enhance worker's skills and technical knowledge. Workers can be trained on the implementation of codes of practice (COPs) and standard operating procedures (SOPs) in the aluminium industry, while keeping in mind the integration of EMS into these documents. Afterwards, as a result of the training, workers' attitude and behavior towards environmental risks will change as they will start adopting healthy environmental practices to avoid environmental accidents. With time, an environmental focused culture within the organization can be fostered, where all employees strive towards sound environmental practices in all daily activities. Knowledge-sharing regarding environmental aspects, impacts and probable mitigation measure would also prosper under the environment-based culture that supports the efficient EMS implementation (Hilson & Nayee 2002).

As such, integrating the Environmental Management System (EMS) into the work processes, procedures and policies is imperative. What is even more important, however, is maintaining the sound environmental practices based on efficient EMS implementation. This usually occurs within the concept of continual improvement by providing employees the resources to accomplish environmental objectives, which are usually challenging and are updated as needed (Nawrocka & Parker 2009). Employees welfare, abundance and availability of resources to combat pollution should not be compromised based on limited financial resources. The deficit in welfare may directly lead to reduction in the ability to meet EMS targets, which will cause failure in the EMS system and deprive the organization from enjoying the benefits of

EMS (Comogilo & Botta 2012). Mental and physical welfare are both considered important in the implementation of the efficient EMS since they include providing facilities, services, benefits, appropriate work load, culture of respect and appreciation, and opportunities to develop personally and professionally. Employees welfare can only reflect positively on the employer by enhancing his/her image and increasing the productivity in the workplace. In regard to aluminium industry, employee welfare leads to enhanced employee facilities. It also leads to a positive work culture where suggestions are heard and resources to treat hazardous reduction cells waste and minimize environmental impacts are provided (Barr 2007).

Risk mitigation and autonomous systems are the other elements that contribute to the control of human factors. The environmental accidents are not less severe than other safety and health related accidents. The Ajka Alumina plant accident in Hungary was an example where an environmental accident led to destruction of homes, an entire village, and an ecosystem (Pulitzer Center on Crisis Reporting 2011). Therefore, risk assessment, management and mitigation with relevance to the industry type is essential since risk and human error are closely interrelated.

Human error is almost existent in all risk assessment. It is important to note; however, that risk estimation controls the process of risk mitigation. The larger the estimated risk is, the more emphasis there is on mitigating the risk and containing human error (Bernardo et al. 2009). Estimating the risk depends on the type of the technical aspect in hand and the managerial decision-making process in which lesson learnt from the past can be employed. For example, in aluminium industry, the process of handling coal tar pitch content that forms the carbon anodes of the reduction cells could be ranked as one of the riskiest types of processes in the aluminium plant as it results in fumes that negatively affect the individual as well as the environment. Managing and mitigating such risk is of utmost importance where providing cartridge masks and fume treatment plants are considered essential. Moreover, handling process units and pot line operations are also considered risky operations and result in emissions of hydrogen fluorides which impacts human health and the environment. Appropriate hydrogen fluoride reduction technologies or autonomous alumina feeding system are employed as risk mitigation techniques to control the risk in the aluminium industry. Here, the human element in managing the environmental risk is according to the severity and likelihood of the risk. Finding efficient risk mitigation solutions and exploring opportunities for autonomous systems may help in reducing

human factor, especially in technically sophisticated, sensitive and delicate operations (Dahlström 2003).

The issue lies in ensuring that mitigation measures are sufficient enough to reduce or eliminate the risk. Environmental Management System (EMS) provides a platform for checking if the risk mitigation actions are completed. In power systems, for example, risks can be oriented to significant environmental aspects affecting nature conservation efforts and noise. Mitigation commitments are documented in a table where employees sign off upon the completion of actions as per the environmental management plan (Marshall 2004). However, what is needed is more than a check exercise where technical experts or auditors can provide input to the strength of a mitigation measure or the ability of an autonomous system to function without human aid (Alberti et al. 2000).

To sum up, an efficient Environmental Management System (EMS) relies heavily on the control of human factors through strong policies and procedures, along with risk mitigation and autonomous systems that reduce the reliance on human for sensitive operations. It is important to remember that employees' welfare plays a significant role under the policies and procedures of an organization and it can only result in an improved EMS implementation process.

## **2.6 Environmental Awareness**

The final pillar of the efficient Environmental Management System (EMS) is environmental awareness. It is essential to have a strong awareness program for a successful EMS experience. Staff should be trained on understanding the environmental policies, procedures, environmental aspects, impacts and mitigation measures related to their line of work. Moreover, they should learn how to achieve environmental compliance objectives and what their roles is in this regard. This is detailed in the ISO 14001 EMS requirements where training records should also be kept (Prakash & Potoski 2006).

For the aluminium industry, it is important for staff to understand the impact of the plant operations on the environment and the employees, as a constituent of the environment surrounding the plant itself. Generation of waste and emissions from processing units may have harmful impact on the individual and the environment, if not mitigated to an acceptable level. Awareness is the first line of defense for problem solving to reduce environmental impacts (Potoski & Prakash 2005). Studies reveal that long-term employment at the operational units of the aluminium industry is directly linked to Alzheimer disease through occupational exposure to

aluminium dust and powder. Other diseases may also be linked to aluminium toxicity such as Dementia, Parkinson's and Autism. (Kidd et al. 2001). Through technological advancement in the field of medical science, opportunities have been explored to control this aspect through chelating agents and limiting exposure to the dusty aluminium processes. Installing fabric filters or cyclone air filters also serve as options to control aluminium dust (Alvarez 2005). Environmental awareness and recent technological advancements play a significant role in educating staff so that they understand the significance of the environmental aspects related to their line of work.

The main two elements of environmental awareness for an organization are staff competence and capacity building. Training with relevance to the staff roles includes understanding of the recent technological advancement in the field. Staff competence is the skills, technical knowledge and traits that employees need in order to perform their jobs efficiently. It is important that staff are competent enough to perform the job they are hired for. In many cases, employees are assigned jobs that do not match their expertise, thereby preventing real benefits for the organization. Eventually if he/she has not adapted well, they could lose interest in the job and increase staff turn-over rate (Shriberg 2002). Specific job descriptions are required for all jobs within an organization. Elements related to the Environmental Management System (EMS) compliance should be embedded within these job descriptions. In the aluminium industry, specific job description with EMS framework requirements should be available for staff working in casting, smelting, anode baking, process optimization, engineering, maintenance and other processing units. For the supervisory jobs, a comprehensive job description should be written so that staff recognize their obligations and adhere to the requirements (Gómez 2004). Frequent training to increase staff competency with relevance to environmental awareness should be administered. All staff, experienced or novice, should attend training/refresher sessions that are regularly updated to suit the requirements of the attendees and their technical field of work. With time, staff would develop valuable experience which can be passed on to other staff through capacity building programs. It is essential to have capacity building development within the organization to ensure that the knowledge is retained, regardless of staff movement and instability (Eakin & Lemos 2006).

At a larger scale, many organizations aim to transfer knowledge and skills through capacity building between the organizations. For example, The United Nation Development Program

(UNEP) has exercised capacity building for the community that they dealt with as a part of development programs to achieve social, economic and environmental goals. As Jørgens (2012) explains, UNEP went beyond improving knowledge and skills to improving the institutions, organizations and systems in the desired communities. Therefore, it is important to have a holistic strategy within the organization to ensure that knowledge and skills are nurtured. In fact, some contracts have specific terms and conditions on capacity building to retain knowledge and skills for their employees during consultancy services procurement.

The other element of environmental awareness is the relevance of the training to the role of the employees, while making sure that there is emphasis on recent technological advancement in the field of the organization. Training should be tailored enough to suit the level of the staff and their job requirements. Random environmental awareness training in aluminium industry does not suffice to fulfill environmental training needs of the staff (Bohdanowicz et al. 2005). Also, the training should include all recent technological advancement in the aluminium industry including new environmental protection technologies or air pollution control equipment. Even if the organization has not adopted these recent technologies, it is important for staff to have an overview and update on their industry advancement. Additionally, the context of environmental protection, global environmental issues such as climate change, green supply chain, industrial ecology and circular economy could be potentially good hands-on training topics that can be applied according to the nature of the organization. This keeps the organization up-to-date with recent environmental views in the field. Experts within the organization field can be brought in to speak about their experiences and to enhance global knowledge-sharing. This way, practices within the organization can be benchmarked and compared to international best practice, which may instigate a positive change in the plant operations (Boks & Stevels 2003).

In conclusion, environmental awareness is another pillar of the efficient Environmental Management System (EMS) and it should be updated as necessary. Staff competency, capacity building, tailored environmental training for technical staff and recent technological advancement to the field are important aspects to consider while planning the training within the organization.

Fig. 61 below explains a general guideline for the industry, government, organizations, leadership, management, and NGOs to understand their roles in the efficient Environmental Management System (EMS) cycle. This links directly to construction end users that benefit from



the production of a green aluminium metal. First, leadership at the highest level provides direction and leads by example when it comes to issues related to environmental management and sustainability practices. Leadership in UAE at the highest level has set a standard of excellence in the environmental protection and performance. The late Sheikh Zayed bin Sultan Al Nahyan, founder of UAE, has placed the environment at the top of all agendas to be pursued. He said: "On land and in the sea, our fore-fathers lived and survived in this environment. They were able to do so because they recognized the need to conserve it, to take from it only what they needed to live, and to preserve it for succeeding generations." (The Emirates Center for Strategic studies and Research 2004).

Secondly, relevant government bodies set laws, regulations, policies and governance systems. Examples of government bodies of relevance are the Ministry of Climate Change and Environment (MoCCE) at the federal level and the Environment Agency—Abu Dhabi (EAD) at the local level. The main law that governs environmental protection and development in UAE is Law No. 24 for 1999. However, the current gaps lie in the enforcement of the law and monitoring activities as mentioned earlier. Third, if the environmental laws and regulations are stringent in the country, then the organization will comply to them. If not, then the organization will follow the rules, regulations and legislative system of the industry's mother-company, which is usually tailored to the need of the industry. Fourth, management in the aluminium industry establishes the Environmental Management System (EMS) in the organization and facilitates resources. This can be done concurrently with the NGO's consultation process over the industry establishment and the effectiveness of EMS in tackling the environmental concerns of the industry. Fifth, the technical staff implement the EMS using strategic framework approved by management, whether ISO 14001 or other systems, to ensure compliance. Sixth, the pillars of the efficient EMS include Policy and Planning, Implementation, Education, Monitoring and Review. Seventh, the individual staff follows the EMS to produce sustainable aluminium. In the eighth and final step, the construction sector receives the sustainable metal for direct application in the construction projects.

## 2.7 Guideline for Implementation of an Efficient EMS Framework

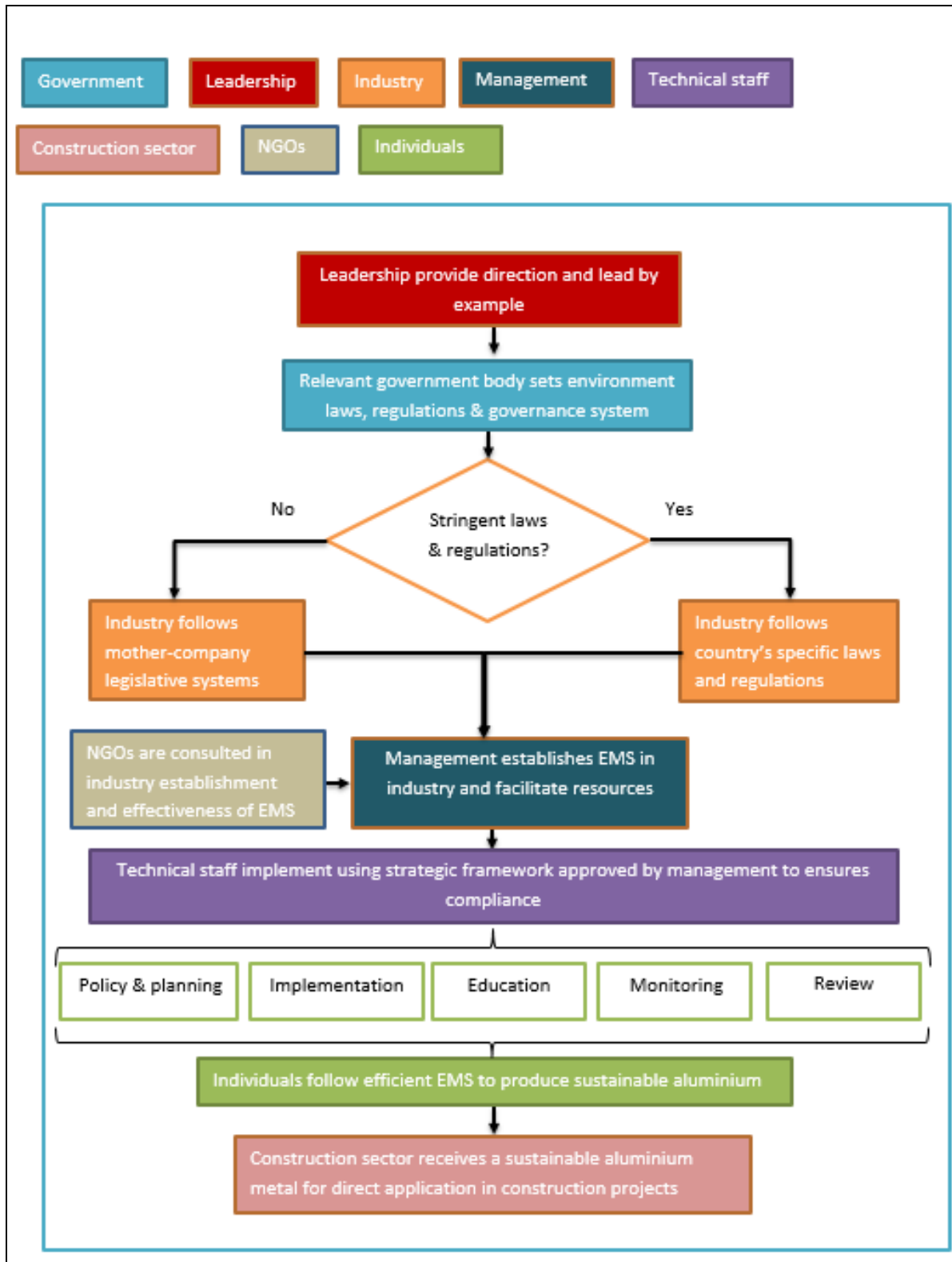


Figure 61: Proposed general guideline for establishing roles and responsibilities to implement an efficient EMS Framework.

The question is what would be the difference to the construction process by using a sustainable green aluminium that has followed Environmental Management System (EMS) requirements? What benefits can sustainability add to the aluminium production and use in the construction field? Is there a difference between an aluminium metal produced in China and an aluminium metal produced in Canada? In terms of perception, sustainable aluminium production process leads to a clean metal that has a reputation to be used confidently in major construction projects. Bribián et al. (2011) believe that it is insufficient to look at the sustainability of the aluminium at its application in the construction projects stage; rather, a holistic view on the entire life cycle of aluminium should be adopted based on a cradle to grave approach i.e. from raw materials mining to final disposal or recycling. The major link can be established based on other indirect sustainability factors such as the Life Cycle Assessment (LCA) of the aluminium, Green Supply Chain Management and Environmental Footprint of the aluminium life cycle as illustrated in Table 9. These three major sustainability elements link directly to the production of sustainable and green aluminium metal production and use. In turn, by following the proposed framework and applying an efficient EMS process that includes these three sustainability elements, the production of a green aluminium metal is secured. Consequently, the construction industry can directly reap the benefits of the sustainable aluminium metal production.

**Table 9. Sustainable Aluminium Production and Its Application in the Construction Industry.**

How can sustainable aluminium metal production process influence the application of the end-product in the construction industry?		
Aluminium Life Cycle Assessment (LCA)	Green Supply Chain Management	Aluminium Environmental Footprint Reduction
Identification and quantification of the amount of energy, consumed materials and generated waste released to the environment through the Life Cycle Assessment (LCA) tool can determine the environmental burden of the aluminium metal. LCA	By studying the environmental loads of the supply chain processes, it turns out that any small change in the processes within the supply chain can cause significant environmental performance improvements. Improving the company's	Having a sustainable aluminium metal with less environmental impacts during manufacturing, clean aluminium production processes and reduced environmental and carbon footprint can positively work as a marketing tool for the

approach is useful in accounting for the upstream impacts, it is a great tool for impact quantification of the use of aluminium in construction as it tracks the associated environmental impacts from cradle to grave and serves in decision making process to choose a specific aluminium product in construction application based on its associated green manufacturing processes.	environmental performance has a positive impact on the economic and the financial performance of the company and may open the door to other opportunities. Sustainable supply chain management may increase the company's competitive advantage in the market. This in returns has a positive impact on the application of the aluminium in the construction projects.	purchase of this metal. A sustainable environmental performance indicator can be used to find proper balance between cost and environmental impacts such as energy and carbon footprint, emissions, waste, and resource consumption. It is essential to understand that reduced environmental footprint of an associated product may increase its environmental reputation and green purchasing potentials.
Relevant Authors and References		
Tan & Khoo (2005)	Stefan and Paul (2008)	De Benedetto and Klemes (2009)

## 2.8 Framework Summary

The proposed EMS framework is defined by a conceptual framework, EMS diamond, elements for effective implementation of EMS and guideline on the roles and responsibilities of entities working within the EMS. The discussion of the elements that constitute a successful EMS framework includes legal framework, enforcement and implementation, leadership commitment, control of human factors and environmental awareness. In order to confirm the applicability of this proposed EMS framework, qualitative and quantitative validations are performed in the following chapter.

## **Chapter 7: Framework Validation**

### **7.1 Framework Qualitative Assessment and Validation**

The proposed framework discussed in this study can be validated qualitatively and quantitatively. Qualitative validation chiefly addresses industry experts and academic professionals that have a contribution in reviewing the applicability of the framework to the aluminium (and any other) industry. Framework qualitative assessment is based on industry professionals and academics feedback, which have been chosen based on their discipline expertise in the environmental management and implementation process. It is essential to evaluate the applicability and the efficiency of the proposed framework in addressing the gaps of the current Environmental Management System (EMS). For that without evaluation, it would be difficult to assess the relevance and the strength of proposed framework. The worth and the added value of the proposed framework can be determined by systemic assessment, subjective human interpretation and critical feedback processes (Spencer 2003).

Literature review lists many methods for the EMS implementation process that are relevant to the scope of this research such as management oriented system models and cost benefit analysis. The management oriented models include a set of essential management actions that steer the implementation of a system. In this context, EMS implementation includes essential steps and activities to be conducted so that the EMS experience at the facility becomes successful. These essential steps include but not limited to laws and regulations establishment, enforcement and implementation as factors that introduce change to the current system of operations. Without these essential steps, the EMS experience at the facility would not reach its full potential. In order to test the effectiveness of the proposed EMS model, this would require actual implementation of the framework, rather than a forecasting model. As for cost benefit analysis method, it is basically an economic evaluation technique that weighs the benefit of the system versus that direct and indirect cost associated with the implementation. The main term used in the cost benefit approach is monetary value; which could be risky as there is limited count for social and environmental value (Butler 2002).

Glaser and Strauss (2009) provided strategies for qualitative type of research through their grounded theory in attempt to provide a holistic framework to generate formal theories, assess them and verify their applicability and results reproducibility. This is efficient in relation

to this research as generalizations and conclusion can be made based on qualitative/semi-quantitative data. Feedback based approach is mainly used in consultation with industrial and academic evaluators. Rossi et al. (2003) describe program evaluation in the context of social research methods by adapting political and organizational environment required to inform a social action or enhance a social condition. In the context of systems and programs evaluation within organizations, continual evaluation can greatly enhance the effectiveness and the management systems within the organizations and it differs from monitoring. Collecting data, results and outcomes of processes, and monitoring performance can be used as an input to the periodic evaluation program within organizations to elevate its efficiency and accuracy (Tong et al. 2007). Depending on the program stage, formative and summative evaluation techniques can be used. Before the program begins, an “assessment” is required. Next stage comes when the program is new, where “process implementation evaluation” is required. However, for established program, “outcome evaluation” is required and for mature programs, “impact evaluation” is needed (Rossi et al. 2003).

For such, the main evaluation criteria used during the Environmental Management System (EMS) program would be both assessment and process implementation. The refined categories for input depends on these four pillars: applicability, effectiveness, strength and weakness. Feasibility, resource availability and implementation challenges are also discussed as essential part of the feedback. There is a need for industrial and academic evaluators to assess the proposed EMS framework efficiency theoretically and practically. The expertise of the evaluators and their relevant background to the research field are the main criteria used to select these evaluators. The same aluminium industry interviewees are subjected as well to the process of EMS framework validation. The applications of the EMS framework are discussed within the profile of UAE aluminium industry. This framework, according to experts of the industry, can achieve the goal of efficient implementation process of the EMS in addition to providing management with a platform to further enhance the system. However, several remarks are made to further enhance the system.

### **7.1.1 Industry Experts Feedback**

Manager 1 mentions that the framework positively reinforces the process of the Environmental Management System (EMS) implementation in the aluminium Industry and

highlights the gaps and defects in the current operational system. However, he suggested that the leadership commitment is already active in UAE aluminium industry; therefore, the emphasis on this aspect through the proposed EMS framework may not be required. He also mentioned that the lack of resources, whether human, organizational or financial resources, is not well reflected in the EMS framework. In contrast, employee 1 had also the opportunity to review and comment on the EMS framework. He mentioned that it would be beneficial to receive hands-on environmental training according to the job description of the employee. He also suggested giving financial incentives to those who follow the environmental management system requirements. During discussion, the proposal to link the employee's performance appraisal with adherence to the environmental management system requirements was also suggested. This will encourage staff to seek improvement in their performance by following environmental regulations and best practice.

Manager 2 mentioned that the proposed Environmental Management System (EMS) framework is well structured and addresses the issues of EMS implementation in the industry. He mentions that it is only at audit time that compliance is emphasized; therefore, regular audits should be part of the proposed EMS framework. Manager 2 suggested that aluminium industry should be self-regulatory in a similar way as the oil and gas industry in the UAE is. The reason is that the aluminium industry requires experts in the specific field of aluminium manufacturing and that government regulators may not be specialized enough to set the regulations for this unique industry. On the other hand, employee 2 mentioned that communication between management and staff requires further illustration in the proposed EMS framework. He mentioned that he often receives inaccurate information regarding his work objectives due to lack of coherent communication from management. Other than this, the proposed EMS framework is well-established.

### **7.1.2 External Reviewers Feedback**

Two external evaluators, evaluator 1 and evaluator 2, whose profiles have been provided in appendix C were requested to review the proposed framework for additional feedback as experts in the Environmental Management System (EMS) field. External evaluator 1 mentioned that one of the statistics show that approximately 25% percent of the world aluminium is used in

the construction industry (Luo & Sorin 2007). He also mentioned that the proposed EMS framework is well written and very informative. He provided the following minor comments:

- In enforcement and implementation, there is a need to provide resources and support to the representatives at the management level. There is also a need to review EMS on a regular basis in-order to ensure its effectiveness.
- In leadership commitment, there is a need to improve the communication processes between the external and internal parties in order to discuss the environmental aspects very actively.
- Under leadership commitment, a definition of the responsibilities required and a steering committee for EMS could be established.
- In EMS planning and objectives setting, objectives and targets should be set because they are linked to other EMS activities.
- Under the checking and monitoring, all the EMS records should be saved and there is a need of auditing in this process.
- Current situation of the organization can be added as the first step in the proposed EMS work because it will help us to compare the organization efficiency after the implementation of EMS.

External evaluator 2 likes the idea of a new Environmental Management System (EMS) framework as the existing types of EMS always seem to be tied with the Health, Safety and Environmental Management System (HSEMS), and since this inevitably leads to competition between health, safety and environment. Safety, understandably, usually wins this battle which is unfortunate for the sake of environmental pressing concerns. Environmentalists are mandated to make sure that the management are aware of the environmental performance and try to convince them to address environmental issues the company may be facing. This is where a fresh approach to EMS, as the proposed framework suggested, may be useful. A visible industry guidance for the Environmental Management System (EMS) was identified by external evaluator 2 which is the EMS data on International Environmental Management Association (IEMA) site. He suggested that if a new EMS framework is to be adopted, it should be driven by the same kind of environmental industry leader, such as IEMA.



### 7.1.3 Summary of Feedback

In fact, the feedback received has elements that were addressed in the original Environmental Management System (EMS) framework version in ISO 14001:2004 and has been updated in 2015 version with emphasis on specific aspects of importance. The proposed framework is only dealing with the current gaps in the system and has not documented the process of ISO14001 EMS implementation. However, as per the feedback received, additional enhancements were made to address all remarks, accommodate the process of ISO 14001 EMS implementation, highlight the gaps and shape the final proposed EMS framework for the aluminium industry. Table 10 has documented a summary of the feedback received from the aluminium industry experts and external professional reviewers.

**Table 10. Summary of Feedback received from Aluminium Industry Experts and Professional Reviewers.**

<b>Reviewer</b>	<b>Feedback</b>
Manager 1	Leadership commitment is sufficient Availability of resources, whether human, organizational or financial, is not well reflected in the EMS framework
Employee 1	Hands-on environmental training according to job description is welcomed Financial incentives for those who follow environmental requirements Linking employees' performance appraisal with adherence to EMS requirements
Manager 2	Regular audits to be added to the EMS framework Request to self-regulate the aluminium industry as it is specific and highly technical
Employee 2	Communication is not well documented in the proposed framework
External Evaluator 1	<ul style="list-style-type: none"><li>• In enforcement and implementation, there is a need to provide resources and support to the representatives at the management level. There is also a need to review EMS on a regular basis in-order to ensure its effectiveness.</li></ul>

	<ul style="list-style-type: none"> <li>• In leadership commitment, there is a need to improve the communication processes between the external and internal parties in order to discuss the environmental aspects very actively.</li> <li>• Under leadership commitment, a definition of the responsibilities required and a steering committee for EMS could be established.</li> <li>• In EMS planning and objectives setting, objectives and targets should be set because they are linked to other EMS activities.</li> <li>• Under the checking and monitoring, all the EMS records should be saved and there is a need of auditing in this process.</li> <li>• Current situation of the organization can be added as the first step in the proposed EMS work because it will help us to compare the organization efficiency after the implementation of EMS.</li> </ul>
External Evaluator 2	<ul style="list-style-type: none"> <li>• Prefers a new Environmental Management System (EMS) framework as the existing types of EMS always seem to be tied with the HSEMS system</li> <li>• Environmentalists are mandated to make sure that the management are aware of the environmental performance and try to convince them to address environmental issues the company may be facing. This is where a fresh approach to EMS, as the proposed framework suggested, may be useful.</li> <li>• A visible industry guidance for the Environmental Management System (EMS) was identified by external evaluator 2 which is the EMS data on IEMA site. He suggested that if a new EMS framework is to be adopted, it should be driven by the same kind of environmental industry leader, such as IEMA.</li> </ul>

#### **7.1.4 Feedback Integration in the Proposed EMS Framework**

The updated Environmental Management System (EMS) conceptual framework is visualized in Fig. 62. Based on EMS framework feedback provided, the added elements include an EMS status scoping, communications, roles and responsibilities establishment. It is important to understand the status of the EMS at the organization itself first before commencing with the EMS planning, objectives, and aspects identification. In addition, clear internal and external communication channels and systems should be established to fluently convey messages related the operations of the EMS. Clear roles, responsibilities matrices and job descriptions with relevance to EMS activities should be also in place as the EMS framework advances to implementation stage.

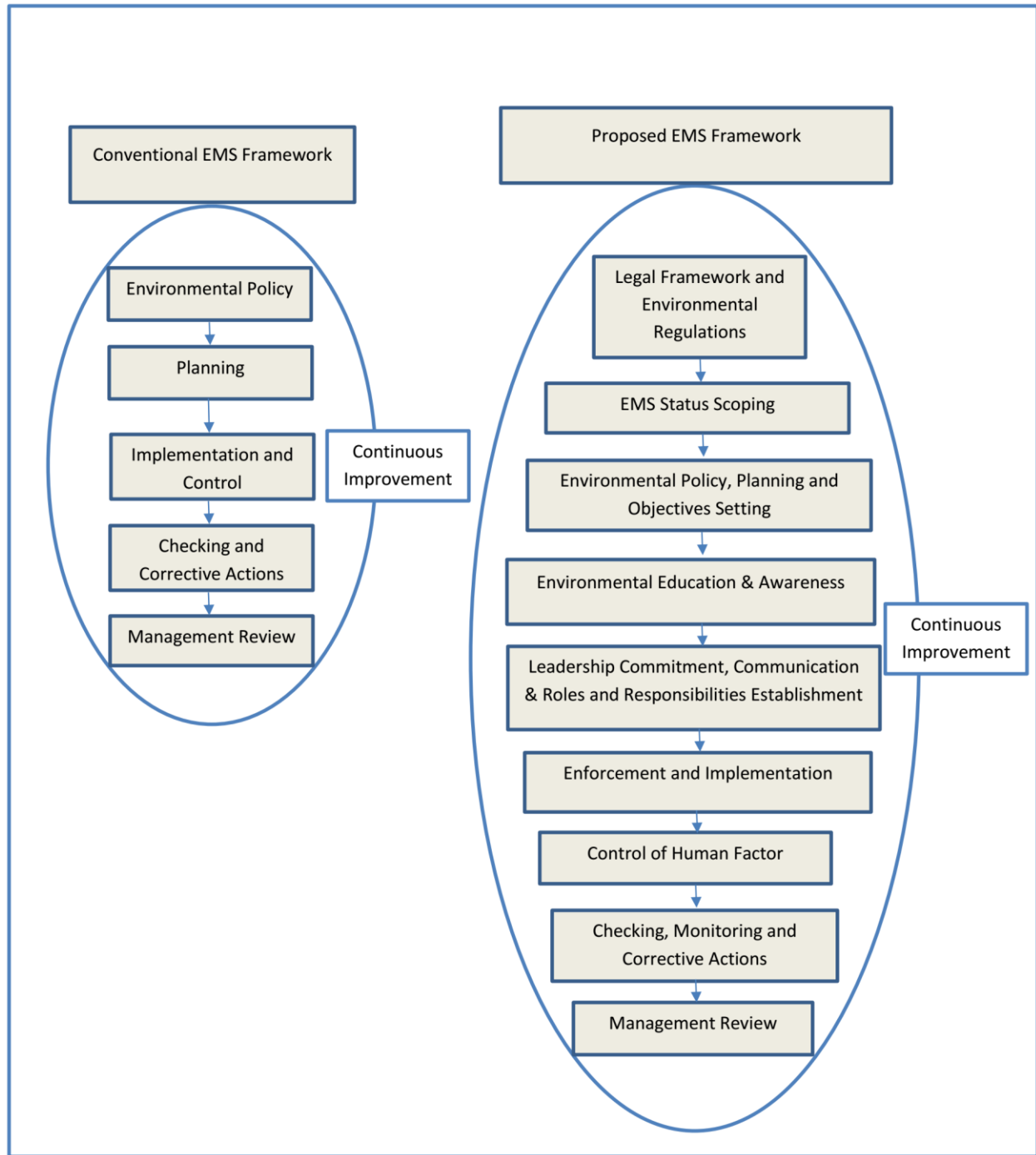
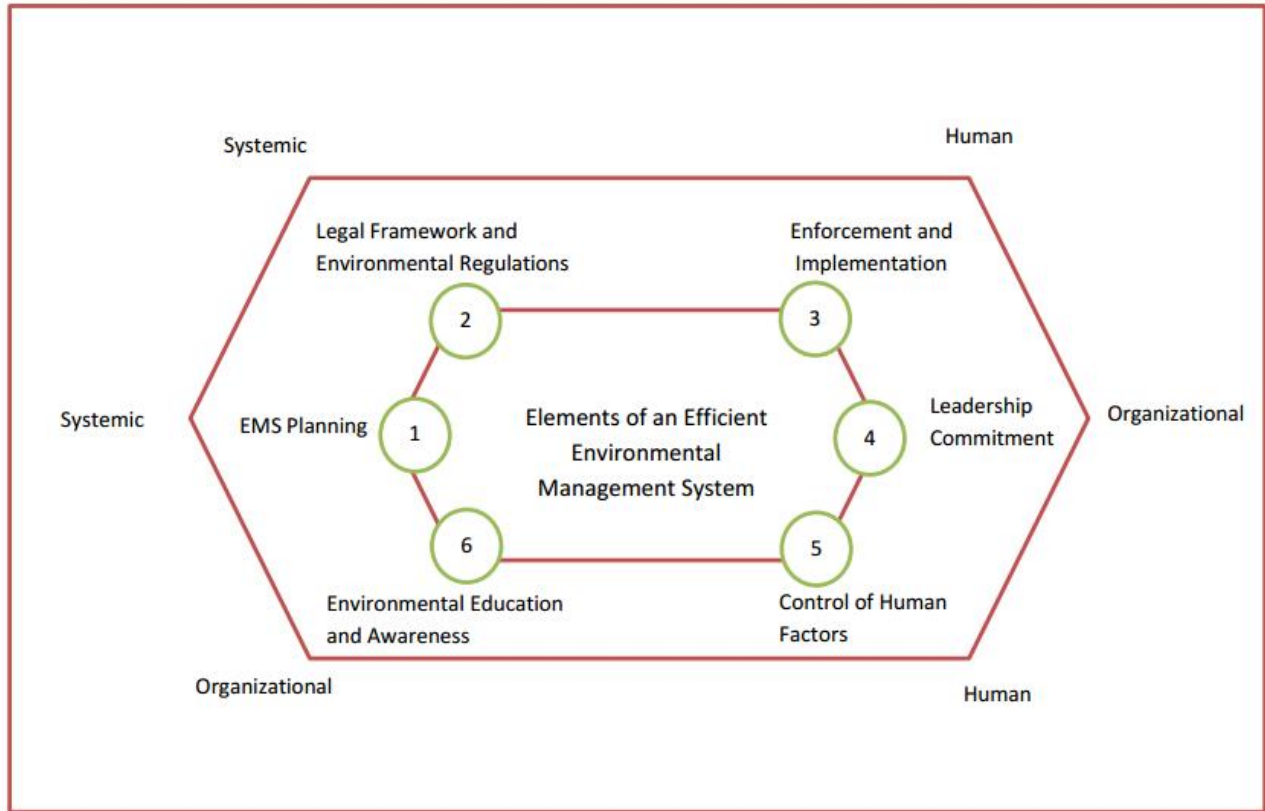


Figure 62: Updated Conceptual Efficient EMS Framework.



**Figure 63: Updated EMS Diamond.**

In addition to the conceptual Environmental Management System (EMS) framework, an updated EMS diamond in Fig.63 has been further developed based on the feedback received from the reviewers. The elements of the efficient environmental management system have been numbered based on their priority in the proposed EMS framework. Additional systemic element was proposed which is EMS planning as it relates to the initial existing steps of the ISO 14001 EMS. EMS planning includes environmental policy setting, objectives and targets setting, and aspects and impacts identification process. The organization identifies their operational environmental aspects such as air emissions or hazardous waste and determine whether these aspects have negative impacts on the environment or people. Significant aspects are dealt with more rigorously by setting high objectives, targets and determining their compliance obligations. Aspects, impacts, objectives and targets setting are among the most critical pillars of the efficient EMS planning process and it requires operational technical experts and environmentalists to sit at one table and understand the significant aspects of their organization (Pun et al. 2002).

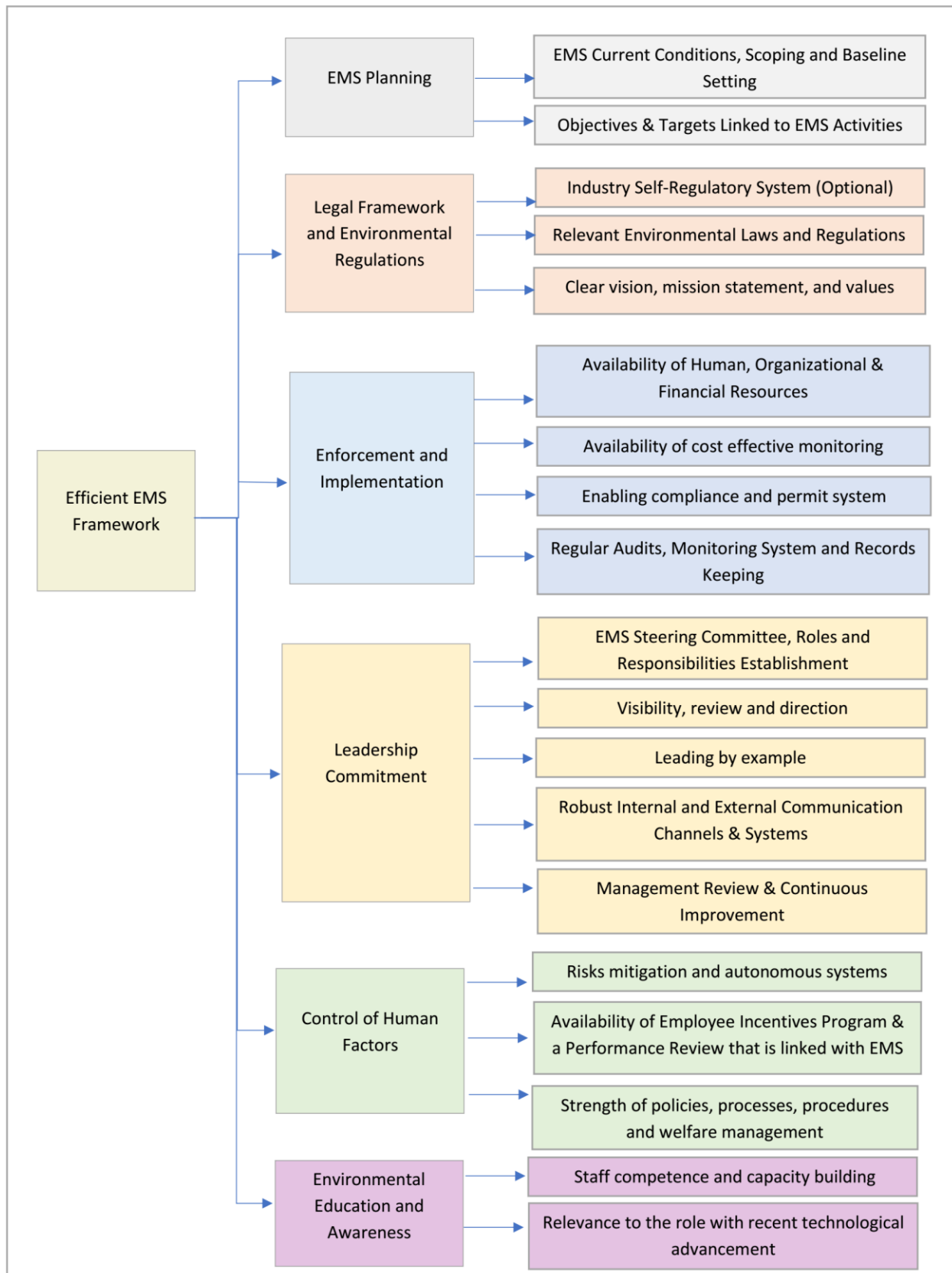


Figure 64: Updated Elements of Efficient EMS Framework.

### 7.1.5 Analysis of Framework Added Elements

The updated elements of the efficient Environmental Management System (EMS) framework can be described in Fig. 64. Additional main element was added which is related to the EMS planning process. The main two sub-elements of the EMS planning are: EMS current conditions, scoping and baseline setting; and objectives and targets linked to EMS activities. The importance of the EMS planning process resides in identifying the activities of the organization that have significant environmental impacts. In addition, scholars like Seiffert et al. (2008) mention that this is the right stage where environmental goals, objectives and targets can be defined. Planning is a key element of a successful EMS framework. It is also essential to understand the EMS current status by a scoping process to understand the baseline conditions. This would allow the EMS steering committee to build upon the existing efforts, rather than starting the EMS process from the beginning (Balzarova et al. 2008). Specific objectives and targets linked to EMS activities would be ideal for the case of the aluminium plants. For example, a specific percentage of waste that is annually being recycled can be set as a target.

As per the feedback received from the evaluators, several sub-elements were added to each of the main elements of the efficient EMS. In legal framework and environmental regulations, the optional sub-element of industry self-regulatory system was introduced. It is proposed that if the environmental regulations at the country of the operational activities are not robust and strong enough to cover the environmental impact of the organization, then the industry may follow a self-regulatory system imposed by an environmental industrial leader in the field, such as the International Environmental Management Association (IEMA) scheme. The role of the industry leader has been reflected in Fig. 65 as well. According to Molina et al. (2008), the industry environmental leader can well establish the general rules of good environmental practices at the industry and can also be specific enough to cover the entire aspects and impacts of the organization. In enforcement and implementation element, availability of human, organizational and financial resources, at least at a minimum level to make the EMS functional, is required in order to operate the EMS at the facility. These resources should be readily available at the facility keeping in mind that most of the EMS related activities are focused more on managing staff and activities, rather than budget intensive (Christini et al. 2004).

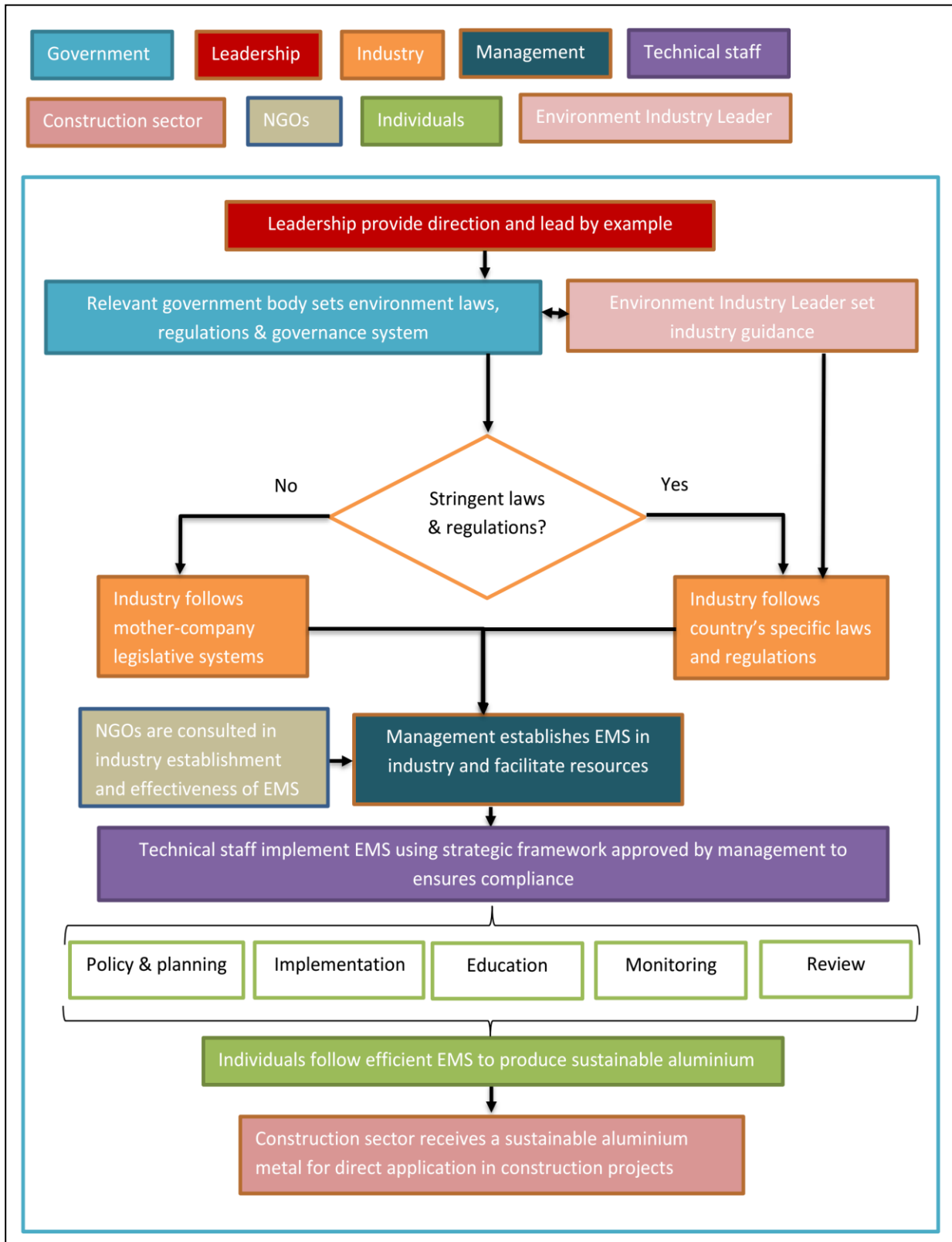
An EMS steering committee comprised of key personnel working in management and operational positions would generally serve as a good base to implement EMS related tasks and functions. The ISO 14001:2004 version suggests a management representative to undertake the role of the EMS implementation. However, as Da Fonseca (2015) mentions that this framework and the ISO 14001:2015 agree upon the requirement of distributing the responsibilities among the job description of the EMS steering committee. Regular audits, monitoring and records keeping strengthen the enforcement and implementation process as it is essential to identify the gaps and the non-conformances of the system during the audit process. In fact, some interviewees mention that the EMS can only be visible during the audit process. The ISO 14001:2015 mandates less record keeping than the ISO 14001:2004 has set which makes it difficult for the auditor to evaluate the depth of the monitoring and the record keeping activities (Lewandowska & Flejszman 2014). This framework suggests intermediate level of documentation; however, as comprehensive as the ISO14001:2004 since clear records keeping is a good habit for any system to thrive upon.

In leadership commitment element, the following sub-elements were added: Environmental Management System (EMS) steering committee, roles and responsibilities establishment, robust internal and external communication channels and systems, in addition to management review and continuous improvement. As stated, the roles and responsibilities of the management representative should be spread out to the EMS steering committee members and included in their job description. There would be an advantage to the system if the EMS performance can be linked to the employees' performance to provide an incentive for efficient EMS implementation, since the added sub-element of the control of human factor refers to an employee incentive program and performance review process linked to EMS. Moreover, communication is an essential sub-element of the leadership commitment and it can be visible through top to bottom approach in addition to bottom-up approach. Management should be able to hear operational staff and vice versa so that the message is heard in a clear way. Sobnosky (2001) stated the importance of communication as the glue that holds all the other elements of EMS together. He emphasized on the weight of the external and internal communication means and records keeping practices. Communication importance was evident also when analyzing the survey responses received from management and operational employees. Other sub-elements added to leadership commitment are management review and continuous improvement as they were



existent in first version of the framework; however, the feedback indicated that they are not explicitly mentioned in the framework. The element of environmental awareness and education remains unchanged in the process of obtaining feedback.

The proposed general guidelines for establishing roles and responsibilities to implement an efficient Environmental Management System (EMS) framework illustrated in Fig. 65 remains the same since it is high level, except for the role of the environment industry leader when there is lack of governance system in the country of operations. The environment industry leader sets industry guidance, in absence of strong governance system for environmental laws, and regulations.



**Figure 65: Updated Proposed General Guidelines for Establishing Roles and Responsibilities to Implement an Efficient EMS Framework.**

## 7.2 Framework Quantitative Assessment and Validation

Framework quantitative assessment and validation can be achieved by choosing quantitative indicators to retrospectively assess the aluminium industries using previous environmental data, as explained in the following sub-sections.

### 7.2.1 Choosing Quantitative Indicators

For the framework quantitative assessment and validation, a forecasting exercise is employed by choosing key performance indicators reflecting the major environmental aspects of the industry. The chosen indicators are directly linked to the first two objectives of this study, excluding framework development and validation objectives, and are listed below:

- **As per objectives no. 1**, indicators are related directly to external and internal factors affecting the Environmental Management System (EMS) implementation; such as number of training sessions conducted, number of EMS trained employees, number of compliance checks and non-conformances in audits, the number of EMS meetings that top management staff attended, and number of management actions taken towards EMS compliance.
- **As per objectives no. 2**, indicators are related to environmental management tools for performance evaluation. Mainly operational KPIs such as amount of GHGs and PFC emissions, amount of PM generated from processes, amount of consumption of raw materials, fuel and natural resources, amount of hazardous waste generated, percentage of emissions decreased after implementing environmental controls technological advancement etc.

These linked KPIs can be used as formal indicators to measure compliance of EMS proposed framework when implemented. Such indicators can provide a performance trend analysis for the EMS at the facility.

### 7.2.2 Retrospective Quantitative Assessment

As this framework has not been implemented yet, for the quantitative method of Environment Management System (EMS) framework evaluation, a projected/forecasted evaluation method will be adopted using the available data. The benefits of quantifying the environmental

performance are an overall understanding of the organization's environmental impact on the environment, an ability to benchmark the industry internationally in terms of environmental performance, an enhanced compliance level with regulatory requirements and an opportunity for efficient use of energy and resources. The Key Performance Indicators (KPIs) reporting and measurements cover the monitoring, evaluation and measurement requirements of the Environment Management System (EMS). A methodology for choosing and reporting upon the indicators should consider the organization's type, size, location and complexity. For example, for the UAE aluminium industry, the following context information should be considered. The United Arab Emirates is located in the Arabian Peninsula that has a unique climatic condition: an arid land with vast areas of deserts coupled with elevated temperatures and high evaporation rate. This area suffers from scarcity of water resources and it relies mostly on desalinated water that adds pressure on water and energy sources of the country. Although the UAE is rich in oil and fossil fuels, these energy sources are non-renewable and an alternative must be found to fuel the country with its energy requirements for drinking and living needs. Keeping this in mind, choosing the environmental performance indicators for the aluminium industry will rely heavily on the unique environmental characteristics and climatic nature of the UAE.

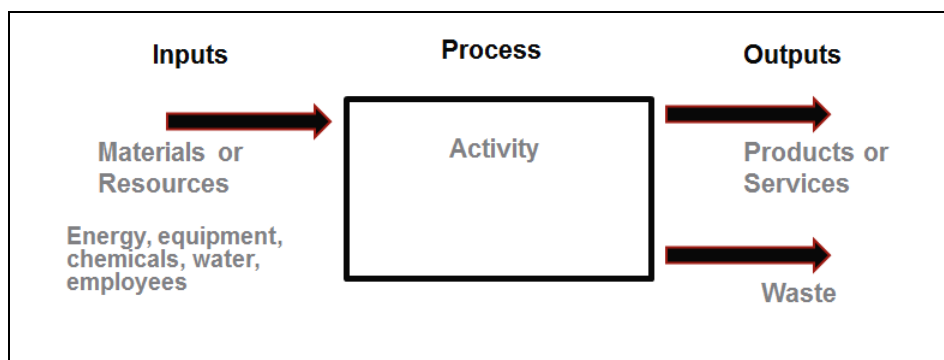
In addition, the selection of the environmental performance indicator is based on the significant environmental aspects, environmental performance criteria and view of stakeholders, if applicable. The ISO 14031 has specified three types of indicators which are management performance, operational performance and environmental conditions. Table 11 provides generic examples of indicators in the industry.

**Table 11. Examples of Environmental Performance Indicators (EPIs) (ISO 1403 2015).**

Indicators Type	Examples
Management performance indicators (MPIs)	Planning, Policy, Procedures, Decisions, People
Operational performance indicators (OPIs)	Inputs, Operation, Maintenance, Equipment, Output
Environmental conditions indicators (ECIs)	Provide Information on Local and Regional Condition of the Environment

To determine significant aspects of the aluminium industry and to better position the KPIs, the Environmental Impact Assessment (EIA) tool can be used. One can use an input/process and

output maps for all the activities as stated in Fig. 66, then a list of the environmental aspects and impacts is developed (ISO 14031 2015).



**Figure 66: Input / Process / Output Model to determine Environmental Aspects and their Impacts (ISO 14031 2015).**

These aspects undergo a prioritization and assessment process to determine their significance. The criteria used to determine the significance of the aspect depends on the following: Degree of release (D), Legal and public requirements (L), Implication of release (I), and Current control measures (C). The values and quantification of each component can be ranked as low, medium and high by environmental experts based on the magnitude and severity of impact, spatial extent and duration of impact (Khadka et al. 2011).

Then, significance is determined through the following empirical formula:

$$\text{Significance} = D \times (L+1) \times (I+1) \times C$$

A matrix for significant aspects, impacts and mitigation measures is then produced and listed in the EIA. The final ranked environmental aspects list per industry is developed. As per the Environmental Impact Assessment (EIA) study conducted specifically for a UAE aluminium industrial facility, an aspect/ impact list is presented as Table 12 (EMAL 2007). The empirical formula has been used by the EIA experts to produce the listed environmental aspects and impacts for the UAE aluminium industry.

**Table 12. List of Environmental Aspects and Impacts for the UAE Aluminium Industry.**

Environmental Aspects	Environmental Impacts
Air emissions	Air Pollution

Water consumption	Depletion of natural resources
Discharges to water	Marine Pollution
Waste Generation	Soil and Groundwater Contamination
Fuel Consumption	Resource Depletion
Use of natural resources	Depletion of natural resources
Materials storage and use	Land Contamination
Noise and visual impacts	Sound and visual pollution

Based on the significant environmental aspects list and the environmental conditions of the UAE, an example for what environmental performance indicators that would be suitable for the aluminium Industry is stated below in Table 13 as per the guidance of the ISO 14031.

**Table 13. Examples on Specific Aluminium Industry Environmental Performance Indicators (ISO 14031 2015).**

Operational Performance Indicators (OPI)	Management Performance Indicators (MPI)	Environmental Conditions Indicators (ECI)
Energy used annually per unit of Product (MJ/ Kg of product)	Number employees trained (#/yr)	Ambient air quality index around the area (good/ moderate/ polluted)
Amount of waste generated per unit of product (Kg/unit)	Number of Complaints (#/yr)	Change in ground water level (m) which can be monitored annually
Emissions of specific pollutants to air (ton CO <sub>2</sub> / yr)	Number of environmental accidents (#/yr)	Number of fish kills or other species death around the area (#/yr)/ which can be measured through observation
Water Consumption (L/ unit of product)	Number of non-conformances or audit findings (#/yr)	Containment concentration in ambient air (µg/m <sup>3</sup> )

The three key performance indicators areas indicated in Table 13 are chosen and reported upon in each quarter as “actual vs. planned” KPI target. These KPIs can be cross checked and compared with the KPIs that are linked to the objectives of this study. As a result, by choosing available KPIs from Table 13 that are linked to the study objectives and obtained from an operational aluminium industry, the final results of the chosen KPIs for the UAE aluminium industry are presented in Table 14. These KPIs were obtained from an operational aluminium plant in the UAE.

A retrospective analysis approach has been adopted with limitation on the authorized and available data obtained from the UAE aluminium industry. It has been noticed that indicators regarding the aluminium life cycle assessment were not available at the UAE aluminium industry. Table 14 represents some of the actual vs. planned environmental KPI for a UAE aluminium industry for one month of the year and for the entire year. These KPI targets are set by monitoring the values of the parameters for the benchmark year and determining reasonable thresholds through the process of objectives setting in the EMS cycle. It is worth noting that these targets and objectives are continuously improved every year based on the management and performance review process.

To analyze the KPIs in Table 14, for the planned waste generation limit of less than 1510 tonnes, the actual generated waste of 1496 tonnes is approaching the planned figure. The calculated percentage of completion and percentage of difference shapes the performance of the indicators.

**Table 14. Actual vs. Planned Environmental KPIs for UAE Aluminium Industry.**

KPI	UoM	Month		Full Year		% Completion		% Difference	
		Act	Plan	Forecast	Plan	Mon.	Yr	Mon.	Yr
Stakeholders complaints received	#	2	2	20	20	0	0	0	0
Environmental Inspections	#	23	25	264	238	80	109	20	0
Environmental Incidents (Minor/Serious/Major)	#	0/0/3	<5	0/0/46	0/0/50	40	8	60	92

Environmental Complaints	#	0	0	0	0	0		0	0
CO <sub>2</sub> -eq Emissions / T	Kg/t	TBD	TBD	TBD	TBD	-	-	-	-
Waste Generation	Tonnes	1496	<1510	7718	<18120	0.92	57	99.08	43
Waste to Landfill	Kg/t	2.7	<4	3.3	<4	32.5	17.5	67.5	82
Waste Recycling	%	74%	>60%	77%	>60	23	28	77	72

In Table 14, the environmental inspections formulate the management performance indicator detailing the level of supervision, audit and surveillance. It was noticed that the actual number of inspections conducted is less than the planned, producing 80% of completion and resulting only in 20% of difference. Therefore, this KPI is performing reasonably as the percentage difference is small. The more efforts that are exerted in enhancing the quality of environmental inspections, the better the performance of the environmental management system indicators.

The number of the forecasted inspections per year surpasses the planned; therefore, it indicates a healthy in-house environmental management cycle. As for the environmental incidents, the planned KPI is less than 5 and the actual KPI is 3. In this special indicator, the lower the number of environmental incidents, the better is the performance of the environmental management system. The percentage of completion is 40% and the percentage difference is 60%. The higher the percentage of difference is, the better as it indicates a facility with less environmental incidents. The actual generated waste is nearly approaching the planned generated waste. To minimize waste generation, the actual generated waste should be less than the planned generated waste. The percentage completion between actual vs. planned is 57% and the percentage difference is 43%. The higher the percentage of difference, the better. In a similar way, the indicator regarding the waste going to landfill should be treated similarly. The less is the amount of waste going to landfill, the better its reflection on the environmental management cycle. However, waste recycling indicator is treated differently. If the actual recycled waste is more than the planned recycled waste, then this reflects efficiency in the environmental management system. In Table 14, the actual recycled waste is more than the planned recycled



waste as the percentage completion is 23% and the percentage difference is 77%. Therefore, this indicates efficient recycling processes at the organization.

This example of quantitative analysis of KPIs affecting the performance of the Environmental Management System (EMS) provide an estimated approach and forecasted method to predict the key elements affecting the EMS. Accordingly, internal processes should be planned around minimizing environmental impacts of significant environmental aspects arising from organizations activities. These KPIs and targets should also undergo a revision process and continuous improvement cycle to reflect process enhancement and technological advancements happening within the facility.

### **7.3 Change Management and Framework Implementation**

In terms of framework implementation, change management is an important aspect that should be considered during introduction of the framework into the organization. The significant re-direction of resources, including financial, human and organizational, requires further planning and transitional implementation phase to allow gradual and acceptable changes at the facility. It is best to start scoping the current status of the Environmental Management System (EMS) and determine whether there are elements that are well-established and available then build on existing EMS efforts. According to Gluch and Räisänen (2009), management should exercise proper communication protocols during transition phase into the new EMS framework to provide operational employees with adequate time and allow them to cope with changes affecting their daily work. A recognition of the nature of the change and affected work processes should be established within the organization as this is the most fundamental aspect of the management of change. Required modifications, alterations and revision of work practices should be established in a concurrent process to the regular work procedures as Yeung (2006) suggests. To illustrate, Yeung (2006) believes this mechanism aids the organization to ensure business continuity and uninterrupted productivity.

Furthermore, supervised directions can be exercised by the engineers and supervisors to ensure sound implementation of the EMS framework. In addition, frequent meetings between management and supervisory operational staff can be conducted at the transitional implementation period of the EMS framework to update the management on the implementation status of the framework. Constraints, opportunities and challenges can be discussed at these

high-level meetings to avoid creating new risks or hazards due to the implementation process of the proposed framework (El-Gayar & Fritz 2006). The management of change often requires a process of risk assessment and hazard identification within the organizations activities. It is mainly the responsibility of the leadership to define change, guide employees and ensure smooth transition into the new framework. Epstein and Roy (1998) illustrate that the changes will not happen immediately and that an anticipated period of time will have to pass before harvesting the results of the new proposed EMS framework.

The anticipated future challenges of the Environmental Management System (EMS) framework is that the environmental concerns are not weighted fairly against other business, strategic and economic priorities of the organization. Therefore, the EMS may not receive adequate support from leadership when the economic situation at the organization is in stress. According to Goodstein (2011) in his book that it is often well-understood that support functions such as the EMS are among the services that can be discharged at the industry. In addition, other safety, health, sustainability, social responsibility initiatives may take priority at the organization over the EMS. Literature review also states that there is a significant gap in the EMS theory and implementation, which may be another challenge that this EMS framework faces. However, with implementation guide and a process of management review and continuous improvement, the system is regularly being updated to fit the need of the organization (Jorgensen et al. 2006). A change in perspective is the main challenge that this framework faces. Most of the construction professionals evaluate the sustainability performance of their projects by measures of recycling practices, downstream environment friendly processes and end of pipe treatment operations. According to Handfield et al. (2005), the difficulty of this framework would be applying a holistic view for sustainable practices starting from supply chain, raw materials extraction, processing, by-products generation, and end-products. This is where the EMS as a tool can be handy in characterizing the level of environmental efforts and performance to reach a green end-product. Other challenges will be revealed as the EMS phased-implementation process starts at the organization.

#### **7.4 ISO 14001 EMS Update and Proposed Framework**

Other questions may rise during the implementation of this new proposed framework for the UAE aluminium industry. Since the ISO 14001 EMS have been revised recently in 2015 and

industries are currently in transition phase, practitioners may ask questions of how is this framework different than the ISO 14001 recent and old versions, and what benefits does this new framework add in terms of specification and application process. Table 15 describes the main differences between some elements of the ISO 14001:2004 EMS, ISO 14001:2015 EMS, and the proposed EMS framework for UAE Aluminium Industry. Areas of comparison include the scope, adoption status, complexity of records keeping, legal requirements, technicality, leadership commitment, context of the organization and audit process. The comparison aspects are not inclusive; however, they provide an overview of the differences between the aforementioned EMS systems.

**Table 15. Comparison between some elements of the ISO 14001:2004 EMS, ISO 14001:2015 EMS, and the proposed EMS framework for UAE Aluminium Industry.**

<b>Comparison Criteria</b>	<b>ISO 14001-2004</b>	<b>ISO 14001-2015</b>	<b>Proposed EMS Framework</b>
Scope	General for all industries/ organizations	General for all industries/ organizations	Specific to cover the gaps perceived in the UAE Aluminium Industry and enhance the overall environmental performance of the industry
Adoption Status	Voluntary scheme. Some organizations have applied it seeking environmental reputation and international standing	Voluntary scheme. Have not been applied to all industries as they are in transition phase	This EMS framework is independent of the EHSMS as the health & safety subjects are not covered under this framework. The proposal is to have this EMS framework mandatory for UAE aluminium industry. This can be achieved by guidance and instruction from the sector regulatory authority that regulates industries.

Complexity of Records Keeping	Requiring long list of documents and records keeping requirements	Shorter list of documented information requirements	Proposes to have intermediate records and documents requirements to demonstrate the efficiency of the EMS, not as extensive as the 2004 version or as short as the 2015 version. Only mandatory documentations related to the EMS element clauses will need to be demonstrated as records keeping evidence
Legal Requirements	Legal requirements are described within the EMS. Legal requirements are generic to all industries and are not tailored to the needs of the specific industries.	Compliance obligation replaces the legal requirements section with a broader view. However, the issue of tailored legal requirements for the needs of the specific industries remains not addressed and have to be manually added when EMS is implemented.	Proposes to have a governance system to fill the gaps in the local regulations or an Environment Industry Leader to set the regulations, in absence of a governance system. Legal requirements are sector wide and specific to aluminium industry
Technicality	Generalized terminology	Generalized terminology	Deals with technical terminologies relevant to aluminium processing and spent pot ling waste
Leadership Commitment	Their role is hidden and not visible. A management	A stand-alone clause to emphasize leadership role. More visible roles	Requires a steering committee to be established. The EMS activities and responsibilities

	representative takes care of the EMS implementation process	and responsibilities in the EMS implementation. No need for a management representative	to be divided among them. EMS performance can also be linked to employee's performance schemes.
Context of the Organization	There is no established context of the organization. All organizations are treated equally at the audit process with less emphasis on each organization unique status.	A specific clause is dedicated to the context of the organization, which details the limitations of the organization and EMS scope.	Customized context of the organization concerning the aluminium industry in the UAE with implementation guide and elements to focus on at the planning and operations stages.
Audit Process	Rigid and inflexible requirements for the auditee and easier decision-making process for the auditor	Easier process for the auditee and difficult evaluation process for the auditor in terms of justifying based on judgement the fulfillment of certain EMS criteria.	Audit process is established based on the proposed industry EMS framework and pre-defined criteria. It is less time-consuming for the auditor and auditee and has a more focused approach.

## 7.5 Validation Summary

In order to confirm the applicability and the efficiency of the proposed EMS framework, qualitative validation by industry experts' interviews is performed. In addition, quantitative assessment by retrospectively analyzing previous environmental data to find patterns of weaknesses and strengths, which match the elements of the proposed framework, has been conducted. To ensure proper implementation of the proposed EMS framework, a change management culture should be focused on the transition phase.

## **Chapter 8: Conclusion, Recommendations, Limitations and Further Research Possibilities**

### **8.1 Conclusion**

This study aims at evaluating the Environmental Management System (EMS) at the UAE aluminium industry to understand the external and internal factors affecting the implementation process of the EMS. As highlighted through the literature review, the use of green aluminium metal in the construction industry is associated with clean aluminium production practices, environmentally focused supply chain management and a thorough life cycle assessment process. To achieve a sustainable metal production process, the EMS tool was used to measure compliance in the environmental management of aluminium. An industry specific questionnaire has been developed to identify areas of strength and weakness of the existing EMS practices at the UAE aluminium industry. The questionnaire was distributed across the aluminium industrial sector in the UAE and responses were collected.

A population representative number of 371 questionnaire responses were collected, analyzed and verified statistically to identify significant and independent factors affecting the implementation of the EMS. With regards to statistical significance, many questions in the Likert scale indicate a significant difference between management and operations staff. For example, 43% of the operational staff answered that they do not know whether there are environmental improvements after implementing the EMS in their facility. In contrast, 51% of the management staff confirmed that there are environmental improvements after implementing the EMS. This demonstrates a clear gap of communication between management and operational staff. In addition, this stresses the fact that these two populations, management and operational staff, are essentially different. A specific environmental training dedicated to the type of work practiced by the employees was also lacking in the aluminium industry, where a generalized environmental training is often delivered. Moreover, the responses indicated a lack of robust governance and enforcement systems, industry-specific laws and regulations, and permitting and compliance follow-up mechanisms.

The most evident external factor impeding the implementation of the Environmental Management System (EMS) is bureaucratic work, followed by lack of support and weak

enforcement. Internal factors affecting the implementation of the EMS are mainly inconsistent top management support, low awareness of EMS objectives and reluctance to change traditional practices due to disruption and high cost. Critical analysis of environmental management tools used at the aluminium industry, such as measurement and improvement and life cycle analysis, has been undertaken through the case study. The case study was conducted in two aluminium smelter locations in the UAE, Jebel Ali and Al Taweela sites. The main purpose of the case study is to verify the responses obtained through the questionnaire and investigate the status of EMS and relevant environmental management tools in these facilities. It was noted that the application of the life cycle approach was limited at both case study industrial sites. Case study interviews with a chosen set of management and operational staff at two different aluminium smelter locations in the UAE confirmed the results obtained through the EMS questionnaire and clarified the responses. The interviews were conducted with both managerial and operational staff representatives at two aluminium industry location sites. The interview responses steered the conclusions and verified the assumption made on the status of the existing EMS at the facilities. One of the case study sites had a superior and comprehensive EMS experience due to experience gained since the early years of establishment. It was concluded that the implementation of EMS in the UAE aluminium industry is heavily affected by a gap in regulatory compliance enforcement, leadership transparency, accountability, and human factors.

The questionnaire, the case study and its relevant interviews provided converging outcomes, which have been combined and analyzed to propose an integrated framework for efficient implementation of the Environmental Management System (EMS). The proposed integrated framework included organizational, human and systemic elements as essential framework building blocks. It serves as a synopsis of the main gaps associated with the EMS implementation experience in the UAE aluminium industry. Moreover, the differences between the newly updated version of ISO14001:2015 and this proposed framework are mainly in areas of leadership role, context of the aluminium industry globally and locally, scope, complexity of records keeping, adoption status and audit follow up, among other factors. The proposed framework includes an industry guidance of the roles and responsibilities of different stakeholders, including government, private sector, internal staff and non-profit organizations, in ensuring efficient EMS implementation experience. The framework ensures a sustainable metal delivery to the construction industry by greening the aluminium supply chain. The framework

was validated by using qualitative and quantitative methods. Initially, a retrospective validation process across individual interviews of the case study reshaped the framework and provided useful feedback. Afterwards, two external industry professionals subsequently provided valuable feedback on the efficiency and applicability of the proposed framework. The framework is considered a unique product in which it provides a foundation for the environmental management in the facility. Frequently, health and safety elements of the management system are weighed higher than environmental elements due to their sensitivity and human health value. Therefore, it is important to separate the environment aspects from the health and safety aspects so that they are not compromised or partially weighed in favor of other elements of the management cycle. The feedback received has been categorized, evaluated, analyzed and considered in the updated EMS framework.

It is essential to test the applicability of this proposed Environmental Management System (EMS) framework in the field to better understand the constraints and opportunities that the new EMS framework provides. The continuous improvement element offers a window for enhancing and upgrading the system to meet the environmental requirements of the UAE aluminium industry. Environment based KPIs, as established through the framework quantitative assessment, can assist in monitoring the implementation condition of the proposed EMS framework. In addition, the feedback received from evaluators, whether external or internal, validated the applicability, functionality and advantages of this new proposed framework by highlighting the shortcomings of the existing EMS processes. The feedback also served as an aid to benchmark the framework to the ISO 14001:2015 EMS implementation process.

## **8.2 Limitations of the study**

This study provides a comprehensive overview of the Environmental Management System (EMS) experience in the UAE aluminium industry. It has tackled main EMS gaps present at the industry by suggesting an integrated framework for the contributing human, organizational and systemic factors affecting the EMS implementation process. However, there are few limitations of the study that may have hindered the research from reaching a full technical extend.

It is noted that this study commenced in 2013 before the release of the new ISO 14001:2015 update. Clearly, the need of such study was evident at the research proposal stage as



the ISO 14001:2004 Environmental Management System (EMS) version has revealed many major implementation gaps among professional practitioners. However, as the research progressed, the updated ISO 14001:2015 was released in 2015 and was compared to the proposed EMS framework suggested by this study. It has been noticed that both frameworks shared similar concepts and high-level approach, with differences in the structure of few elements, which only confirms the integrity of the results and findings leading to similar conclusions. The main EMS gaps highlighted by this study were addressed differently in both frameworks. Therefore, this study reinforced and confirmed the existing EMS gaps at the UAE aluminium industry.

A major factor influencing the outcome of this study is the collection of the questionnaire results. The heavily invested time and efforts spent during the collection of the questionnaire responses has resulted in a technically prosperous framework with a robust methodology and well-structured approach. However, a major constraint to this process was the collection of the questionnaire responses. Due to the modest skill set of some operational staff, a manual paper-based questionnaire was filled rather than an electronic questionnaire. The questionnaire responses were gathered after conducting awareness workshop for the operational staff. This has resulted in a lengthy data collection, input and analysis stage, which consumed a considerable amount of time and efforts. According to NING and YANG (2007), there are benefits in using technological advancement and gadgets such as iPad in data collection; however, paper-based surveys still have their integral place in research data collection methodology since many respondents do not have access to internet or online systems. Many other factors influenced the data collection process such as readability, speed, flexibility and access to target population.

Another limiting factor is the access to aluminium industry's environmental data. It was extremely difficult to obtain industry's environmental data due to its sensitivity and confidentiality nature. These data directly affect the company's environmental image and reputation. The data utilized in this study mainly come from published environmental materials such as the company's sustainability reports and testimonies from personnel working within the industry. In addition, framework quantitative validation process employed the use of previous environmental data rather than current environmental data. To overcome the data sharing obstacle, it is suggested to sign detailed non-disclosure agreement with the industrial aluminium company that specifies what data can be shared versus what data is considered confidential.

Finally, the study did not take into consideration the environmental impacts of the imported raw materials for the UAE aluminium industry as such impacts are local for the country of operation. The focus of the study is within the UAE geographical boundary; therefore, a trans-boundary approach to understand cradle to grave environmental impacts of the aluminium industry was not considered. In addition, this study did not focus on the production of secondary aluminium through recycling of aluminium construction waste, which is considered 92 percent more energy efficient than the primary aluminium production process (Livieri & Lazzarin 2005). The study focused on high environmental impacts manufacturing processes ensuring that these impacts are well-addressed and mitigated through the Environmental Management System (EMS) cycle. This methodology of assessing the sustainability of the aluminium as a metal by looking at its manufacturing practices and its supply chain management is also creating a precedent in the way conventional construction, environmental and sustainability issues are tackled. As prescribed in the literature review, there is lack of historical records, quantitative data and environmental studies covering the aluminium environmental management and sustainability aspects in the UAE. This study aimed at assessing the baseline conditions and status of the aluminium industry in the UAE and it can be considered as initial work to be further followed up by other researchers.

### **8.3 Recommendations**

The application of the Environmental Management System (EMS) in the UAE aluminium industry was used as a tool to assess the sustainability of the produced metal for construction purposes. A questionnaire was developed and distributed among aluminium industry professionals to understand the level of their knowledge and interaction with EMS. In addition, various internal and external factors affecting the implementation of EMS were assessed through the questionnaire. A follow up case study confirmed the results obtained through the questionnaire and allowed for the development of an integrated framework for effective environmental management system at the UAE aluminium industry. The outcome of this study adds a significant value to the conventional EMS systems in the aluminium industry. Further recommendations for following up this research work can be summarized as follows:

- *Creating a stringent legal framework and relevant environmental regulations that are able to guide the aluminium industry in the UAE*

As can be witnessed from the questionnaire results, case study observations and interviews, and framework structure, the legal framework is an essential element of a successful EMS implementation process. Having stringent environmental laws, regulations and sector-specific environmental guidance that encourage sound environmental practices and reduction of environmental impacts are highly recommended. The UAE has Law No. 24 for the protection and development of the environment and its relevant executive orders, which are detailed and comprehensive. However, they do not include full assessment of perceived environmental impacts in sector-specific industries such as aluminium manufacturing nor they include emission limits for pollutants arising from these specific industries. Therefore, it is recommended that a sector-specific environmental guidance be developed to tackle these gaps in absence of a prescriptive environmental law. The regulator has also a direct role in enforcing these regulations or guidance and monitoring the performance of sector-specific industries such as aluminium manufacturing. Thus, the regulator can make this proposed framework mandatory for UAE aluminium industry

- *Cumulatively evaluating the Environmental Management System (EMS) practices for all available aluminium production and recycling stages within the UAE*

This study focused at evaluating the environmental impacts of aluminium at the available stages of production in the UAE, which are mainly smelting and electrolytic reduction process. Other stages such as alumina refinery process and raw material extractions were not considered in the analysis of the aluminium production environmental impacts. However, the UAE is considering building an alumina refinery, which will be first in the region, in the near future. It is recommended that future environmental studies be conducted after the establishment of the alumina refinery to evaluate the aluminium production impacts cumulatively, combining both smelting and refining impacts of the production chain. The UAE does not have Bauxite mining operations as the raw materials for the aluminium production are currently imported. The impacts of these operations can be considered in the life cycle assessment (LCA) for aluminium. An analysis of the Environmental Management System (EMS) for future expansion of the aluminium industry can also be considered. Moreover, this study did not tackle secondary aluminium production processes through recycling of aluminium construction waste. It is

recommended that future studies be conducted to understand the extend and efficiency of the secondary aluminium production process in the UAE. A comparison of the primary and secondary aluminium production EMS practices would be ideal as a follow up research to this study.

- *Creating an aluminium life cycle inventory for individual aluminium industries to feed into the overall life cycle assessment process*

The life cycle assessment process requires the following elements: goal, scope definition, life cycle inventory and environmental impact assessment, and interpretation (Tan & Khoo 2005). It was noted through the case study findings that the life cycle assessment processes at the UAE aluminium industry are not fully developed, implemented and used properly. Therefore, it is recommended that an aluminium life cycle inventory be created in order to allow for an open source of data inventory for practitioners on aluminium manufacturing and related environmental impacts. This will help in the process of benchmarking the UAE aluminium industry environmental performance with the rest of the aluminium production countries. In addition, such data will provide a continuous source of transparent data for corporate sustainability reports that are produced annually.

- *Testing the proposed framework after implementation in the UAE aluminium industry*

Any proposed framework or change in processes can only be fully evaluated after implementation of the framework or the system in the organization. It is recommended that further analysis after the adoption of the new EMS framework at the facility is conducted to validate the applicability of the framework and its areas of strengths and weaknesses. The shortcomings of the framework can be then fed into a continuous improvement cycle until all constraints and obstacle of the framework are resolved.

- *Linking environmental planning aspects with environmental management outcomes for the UAE aluminium industry*

Environmental site planning and preparations have an integral role in addressing the environmental impact of the industry at the early stage. At this phase, conducting Environmental Impact Assessments (EIA) is essential to understand environmental baseline conditions and monitor the site environmental status through operational KPIs. The EIA is also a regulatory compliance tool often used to establish environmental commitments from the proponents and the

leadership. To attain efficient management and operational processes reflecting sound environmental planning and follow up, it is recommended to link Environmental Impact Assessment (EIA) recommendations with the Environmental Management System (EMS) objectives and targets. This continuous cycle of environmental commitments and obligations from planning to execution stage until final decommissioning stage is ensuring responsible environmental management of the industry.

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## Appendix A

### Survey for Measuring the Efficiency of the Environmental Management System (EMS) in the Aluminium Industry

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The main purpose of the survey is to identify the external and internal factors affecting the implementation of Environmental Management System (EMS) at the UAE Aluminium Industry.

**Please tick (✓) on the appropriate answer**

#### Section B. General Information

1-Which Department do you work in?

- ☐ Management/ Senior Engineer
- ☐ Manufacturing /Operations
- ☐ Others

2-What is your gender?

- ☐ Male
- ☐ Female

3: What is your age?

- ☐ 18-24
- ☐ 25-34
- ☐ 35-44
- ☐ 45-54
- ☐ 55-64
- ☐ 65 or older

4- What is your Educational Level?

- ☐ High School
- ☐ Bachelor's
- ☐ Master's
- ☐ PhD
- ☐ Others, please specify .....

5-What is your Experience Level?

- ☐ Less than 5 years
- ☐ 5-10 years

- ☐ 11- 15 years
- ☐ more than 15 years

6-What is the number of employees in your company?

- ☐ Less than 1000 employees
- ☐ 1000-3000 employees
- ☐ More than 3000 employees

7-Which company does you work for? (Optional)

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8- What is your position in the company? (Optional)

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9- What is your nationality? (Optional)

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#### Section B. Evaluation of the Environmental Management System (EMS)

No.	Questions / Opinions	Strongly Disagree	Disagree	Agree	Strongly Agree	Don't Know
1.	<b>There is an environmental management system in place at the facility</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2.	<b>There is an environmental department at the facility</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3.	<b>The environmental policy is visible, accessible to all staff and well communicated</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4.	<b>The company is ISO 14001 Environmental Management System certified</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5.	<b>The company has registered in the local Environment Health and Safety Management System</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6.	<b>The factory undergoes annual internal environmental audits that are conducted by facility staff</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7.	<b>The factory undergoes annual external environmental audits that are conducted by third party such as consultants, regulators and lenders</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8.	<b>The facility conducts regular annual environmental training for the staff</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9.	<b>There is interest in EMS at your facility</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

10.	<b>Lack of funding is a factor that affects the implementation of EMS</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11.	<b>There is strong organizational support towards EMS in your facility</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12.	<b>The environmental related data collected from departments are of good quality</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
13.	<b>Leadership management is committed to transparency in implementing the EMS in the facility</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14.	<b>There is lack of accountability in fulfilling the set objectives and targets</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
15.	<b>Your facility benefits from the marketing and branding in adopting the EMS by increasing the number of clients and expanding business</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
16.	<b>There is real drive of environmental improvements and reduced environmental risk after implementing the EMS</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
17.	<b>EMS implementation saves cost on the facility by achieving reduction in energy, water, waste, purchasing, raw materials consumption and transport</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
18.	<b>EMS implementation improved legal environmental compliance with the regulator</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
19.	<b>Your facility's purchasing department uses a green purchasing policy</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
20.	<b>Your facility has corporate social responsibility (CSR) and it participates in voluntary programs such as clean up campaigns</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
21.	<b>Your facility solicit opinions from environmental non-profit organizations and involve them in site planning or in identifying environmental impacts</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
22.	<b>Your facility have set targets and objectives for all the significant environmental aspects including air, water, solid waste, hazardous waste and noise</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

### Section C. Opinion Questions

1. In your opinion, what is the value of EMS?

<b>EMS Function</b>	<b>High Value</b>	<b>Moderate Value</b>	<b>Little Value</b>
Supporting & coordinating sustainability efforts	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Changing Behavior of employees or managers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Increases awareness of overall EH&S functions and activities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Projects management implementation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Communicating sustainability efforts	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Supporting Accountability	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Achieving compliance goals	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Enhancing company reputation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Others, please mention .....			

2. To what extents have each of the following groups influenced your facility to improve environmental performance?

Groups	Low Influence	Medium Influence	High Influence
Regulators	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Customers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Local community	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Shareholders	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Competitors	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Media	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Suppliers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Environmental Groups	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Others, please mention .....

3. In addition to improving environmental performance, how important are the factors listed below in motivating your facility to implement environmental management practices?

Factors	Not Important	Somewhat Important	Very Important
Improve Regulatory Compliance	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Improve Community Relations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Improve Employee Motivation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Influence Pending Legislation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reach New Customers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Improve Customer Loyalty	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Generate new products/ services	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Improve environmental NGO relations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Others, please mention .....

4. Which ONE the following statements BEST describes your EMS implementation experience over the last few years:

<input type="radio"/>	Scope of our EMS has *SMART objectives and is focused on specific operations or programs
<input type="radio"/>	EMS approach and elements have been formalized and documented
<input type="radio"/>	We have conducted an audit of our EMS
<input type="radio"/>	Our environmental “Aspects/impacts” have been reviewed and updated
<input type="radio"/>	Management has conducted an EMS Review within the past 18 months
<input type="radio"/>	Have seen limited EMS improvement
<input type="radio"/>	formal EMS never got off the ground or lost ground

\*SMART: specific, measurable, achievable, realistic, time-bounded

5. Please rank the below **external** factors affecting the implementation of the Environmental Management System (EMS)

①②③④⑤⑥⑦

Associated Cost

Bureaucratic Work

Insufficient Drivers

Lack of Support and Guidance

Lack of Regulations and Standards

Weak enforcement

The company will lose its competitive edge

Others, please mention .....



6. Please rank the below **internal** factors affecting the implementation of the Environmental Management System (EMS)

①②③④⑤⑥⑦⑧⑨⑩

Lack of Time

---

Lack of Specialists and shortage of personnel

---

Cost constraints

---

Inconsistent Top Management Support

---

Negative Attitude of employees, i.e. the company employees will resist it

---

Low awareness of EMS objectives and continuous improvement cycle

---

Lack of Knowledge in the Industry and difficulties to deal with environmental aspects

---

Reluctance to change traditional practices due to disruption and high cost

---

Lack of knowledge about certifiers and confusion about certification process

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Others, please mention .....

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**Thank you for your time in completing this survey**

## Appendix B

### Appendix - B1

#### Interview Invitation Letter

I am Abeer Sajwani, a PhD candidate in Construction at the school of Energy, Geoscience, Infrastructure and Society (EGIS), Heriot Watt University Dubai Campus (HWUDC), UAE. As part of my dissertation work, I am conducting interviews on 'Enhancing the Application of the Environmental Management System (EMS) in the UAE Aluminium Industry', which aims to explore the EMS experience at your facility, the opportunities and challenges faced during the implementation of the EMS.

The outcomes of these interviews will be used to describe the EMS experience at the UAE Aluminium Industry including the opportunities, challenges and issues of the system. Please refer to attached information sheet for further details.

Your participation for interview is entirely voluntary. You are free to refuse to answer any question and you can also withdraw your responses before 01 June 2016. Interview venue could be any place you feel comfortable. You can also choose a good time to meet. The interview data (and/or any other materials related to the interview) will be kept strictly confidential and will only be used by myself for the study purpose. Your identity will be protected at all times. Further, you will be sent your interview transcript to verify it if you wish to do so.

You can contact me on the details given below. I hope to hear from you soon.

Many thanks,

A handwritten signature in black ink, appearing to be 'AS', written over a horizontal line.

Kindest regards,

Abeer Sajwani  
PhD Candidate in Construction  
School of Energy, Geoscience, Infrastructure and Society  
Heriot-Watt University Dubai Campus  
Dubai International Academic City  
P O Box 294345, UAE  
[as41@hw.ac.uk](mailto:as41@hw.ac.uk)

## Interview Information Sheet

My name is Abeer Sajwani, PhD Candidate in Construction in the school of Energy, Geoscience, Infrastructure and Society (EGIS), Heriot Watt University Dubai Campus (HWUDC), UAE.

As part of my dissertation work, I am conducting interviews on ‘Enhancing the Application of the Environmental Management System (EMS) in the UAE Aluminium Industry’, which aims to explore the EMS experience at your facility, the opportunities and challenges faced during the implementation of the EMS. The outcomes of these interviews will be used to describe the EMS experience at the UAE Aluminium Industry including the opportunities, challenges and issues of the system.

I need your help for this. Therefore, I would like to invite you to take part in interviews talking about the EMS experience at your facility. In fulfilment of research study, I will be writing a dissertation and will be publishing papers in international journals. In this way, my study will give the industry a better understanding of the EMS experience at UAE Aluminium facilities.

### Some questions that you may have

- Should I automatically confirm meeting you for the interview or can I decline?

It is your choice to confirm the interview meeting or decline. No one will mind if you don't want to take part. You can also change your mind at any time or ask more details. Just let me know.

- Where and when we meet?

It could be any place where you usually spend your time, wherever you feel most comfortable. You can also choose a good time to meet.

- Who will be there?

Only I will be there.

- How long it will take?

Around one hour. If you wish you can take less or more time.

- Will you tell anyone what I say?

Everything that you say will be kept confidential. Also, I will send you the interview transcript to verify it before analyzing if you wish to do so. Your data will only be used by me for my research study. But under no circumstances will your name or any identifying characteristics be included in my dissertation or research paper.

- What are the topics of the questions?

Topics include: EMS experience, EMS objectives, Environment Training, EMS Awareness, External and Internal Factors affecting the EMS implementation, and Environmental Performance.

- Will anyone reading the dissertation or research paper be able to recognize me?

No, all data will be anonymous. Therefore, no one will be able to recognize you.

- Where this study is based at?

This study is part of my PhD study fulfilment, which is based at the Heriot Watt University, Dubai Campus.

- How can I get in touch?

You can contact me on:

Abeer Sajwani  
PhD Candidate in Construction  
School of Energy, Geoscience, Infrastructure and Society  
Heriot-Watt University Dubai Campus  
Dubai International Academic City  
P O Box 294345, UAE  
[as41@hw.ac.uk](mailto:as41@hw.ac.uk)

## Interview Consent Form

Title of study: "Enhancing the Application of the Environment Management System (EMS) in the UAE Aluminium Industry"

Name of Researcher: Abeer Sajwani

Name of PhD Supervisor: Dr. Yasemin Nielsen

*Please tick appropriate boxes:*

### *Taking part*

Yes No

I have read and understood the study information sheet.

I have given the opportunity to ask questions about the study.

I agree to take part in the study. Taking part in the study will include being interviewed.

I understand that my taking part is voluntary; I can withdraw from the study before 01 June 2016 and I do not have to give any reasons for why I no longer want to take part.


### *Use of the information I provide for this study only*

I understand my personal details will not be revealed.

I understand that my words may be quoted in the dissertation or the research paper.

I understand that my identity will not be revealed in the dissertation or the research paper.


-----  
Name of participant

-----  
[printed] Signature

-----  
Date

-----  
Researcher

-----  
[printed] Signature

-----  
Date

## Appendix C

### Interviewees and Reviewers Information

Manager 1	
Occupation	Senior Superintendent – Environment Dubai Aluminium Company (DUBAL)
Years of Experience	10 years

Employee 1	
Occupation	Operator/Field Engineer – Pot line Control Dubai Aluminium Company (DUBAL)
Years of Experience	12 years

Manager 2	
Occupation	Environmental Manager Emirates Aluminium Company (EMAL)
Years of Experience	4 years

Employee 2	
Occupation	Maintenance Engineer – Pot lines Emirates Aluminium Company (EMAL)
Years of Experience	3 years

External Evaluator 1	
Name	David Monaghan (MIEnvSc, MIAQM)
Occupation	Environmental Professional expert in delivering environment management, monitoring and permitting projects across the oil and gas, nuclear, heavy industry, infrastructure, manufacturing and energy sectors.

Years of Experience	10 years
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External Evaluator 2	
Name	Waleed Nawaz - MS in Civil Engineering, American University of Sharjah
Occupation	Expert in Civil and Environmental Engineering including the Statics and Mechanics of Materials recitation sections multiple times. He also assisted in various courses including Geotechnical Principles, Mechanics of Material, Structural Concrete Design, Steel Design, Structural Dynamics, Earthquake Engineering and Fluid Mechanics. As a graduate research assistant, he supervised various experiments conducted by different senior design groups.
Years of Experience	7 years

The End